Advisory Committee on Fishery Management

ICES CM 1999/ACFM:6

REPORT OF THE

WORKING GROUP ON THE ASSESSMENT OF MACKEREL, HORSE MACKEREL, SARDINE AND ANCHOVY

ICES Headquarters
28 September–7 October 1998

Part 1 of 2

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

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Summary

The Working Group reports on the state of the stocks of western, southern, and north-east-Atlantic mackerel, southern horse mackerel, western horse mackerel, sardine and anchovy in Divisions VIIIc and IXa, and anchovy in Sub-Area VIII. Corresponding catch forecasts are provided. No estimates of the state of the stocks of mackerel in the North Sea, horse mackerel in the North Sea nor of anchovy in Division IXa are made because of a lack of biological information. Biological sampling of catches has been reviewed. Southern horse mackerel catches are very well covered by the sampling programme. Sampling of commercial catches for sardine, for anchovy in VIII and for mackerel is considered adequate. Sampling coverage for western horse mackerel is poor. No new assessment is calculated for North-East Atlantic mackerel nor for Western mackerel, but a stock projection made from the previous assessment and using reported catches in 1997 agrees well with information analysed to date from the mackerel egg surveys in 1998. The stock appears to be relatively stable at present. Available data on mackerel distributions have been collated. The preliminary information from the western horse mackerel egg surveys indicates a much higher stock size than was expected. The assessments have been revised accordingly, but methodological problems with the assessment of this stock remain to be addressed. The assessments of both north-east Atlantic mackerel and western and southern horse mackerel will be updated in early 1999 when the analysis of egg survey information is complete. The assessment of Southern horse mackerel is closely consistent with that presented previously and there is little change in the perception of the dynamics of this stock. A new sardine assessment model has been formulated to address some methodological problems which have been discovered since the previous Working Group meeting. The perception of the state of the stock remains one in which recruitment is declining and fishing mortality increasing, but estimates of stock size in the 1970s and early 1980s relative to recent stock sizes are now known to be unreliable. A weak recruitment is estimated for anchovy in VIII in 1998, and the stock is expected to decline in 1999 as the strong 1996 and 1997 year-classes cease to contribute to the adult stock. Environmental indices of recruitment have been used for anchovy in VIII and have been proposed for sardine.

Résumé

Le Groupe de Travail s'est intéressé à l'état des stocks de maquereaux de l'Ouest, du Sud et du Nord-Est Atlantique, de chinchards du Sud et de l'Ouest, de la sardine et de l'anchois des Divisions CIEM VIIIc et IXa et de l'anchois de la sous-zone CIEM VIII. Les prévisions de captures ont été fournies. Aucune estimation sur l'état des ressources du maquereau et du chinchard en mer du Nord ainsi que de l'anchois de la Division CIEM IXa n'a pu être fournie compte tenu du manque d'informations sur la biologie de ces espèces. Les échantillons biologiques des captures ont été analysés dans le cadre de la détermination des structures d'âge des populations capturées. Les échantillonnages des captures commerciales pour la sardine et l'anchois de la Division VIII et pour le maquereau sont considérés comme suffisants. Tandis que celui du chinchard de la zone Atlantique Ouest peut être considéré comme très insuffisant. Aucune nouvelle évaluation n'a été effectuée ni pour le stock de maquereaux du Nord-Est Atlantique ni pour celui du stock Ouest. Cependant, une prévision sur l'état du stock, effectuée à partir des évaluations existantes et en utilisant les captures déclarées en 1997, concorde bien avec les informations actuellement collectées lors des campagnes d'évaluation de la répartition et de l'abondance des oeufs en 1998. Le stock apparaît s'être relativement stabilisé. Les données disponibles sur les distributions des maquereaux ont été récoltées. L'information provenant de l'analyse préliminaire des campagnes de suivis des oeufs de chinchards indique que le niveau d'abondance du stock est plus élevé que ce que l'on pensait. Les évaluations ont donc pu être ainsi révisées, mais des problèmes méthodologiques concernant l'évaluation de ce stock demeurent. Les estimations d'abondance des stocks de maquereaux du Nord-Est Atlantique ainsi que du chinchard des zones Ouest et Sud Atlantique doivent être revues en 1999 à la lumière de l'analyse complète des informations collectées lors des campagnes de suivi des densités d'oeufs. L'évaluation du stock de chinchard du Sud est cohérente avec celle qui a été effectuée l'année passée et peu de changements dans la dynamique de ce stock sont constatés. Un nouveau modèle pour l'évaluation de l'abondance du stock de sardines a été formulé pour prendre en compte certains problèmes méthodologiques qui sont apparus depuis la précédente réunion du Groupe de Travail. La perception de l'état de cette ressource est caractérisée par un recrutement déclinant et une mortalité par pêche qui s'accroît. Cependant, les estimations concernant la taille de ce stock dans les années soixante-dix et le début des années quatre-vingts ne sont pas considérées comme fiables. Pour l'anchois de la zone VIII, on estime, à partir des indices environnementaux, que l'on aura un faible recrutement pour l'année 1998 aboutissant à une diminution de l'abondance de cette espèce en 1999, compte tenu de la diminution de l'impact des cohortes 1996 et 1997 sur l'abondance de la population d'anchois adultes du golfe de Gascogne. Des indices de recrutement basés sur la variabilité des facteurs environnementaux (indices prenant en compte l'importance des remontées d'eaux froides) a été utilisé pour l'anchois et a été proposé pour la sardine.

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1 INTRODUCTION

1.1 Terms of Reference

The Mackerel, Horse Mackerel, Sardine and Anchovy Working Group met at ICES Headquarters from 28 September–7 October 1998 to address the following terms of reference, as decided at the 85th Statutory Meeting (1997 Annual Science Conference) (C.Res.1997/2:11:9):

a) assess the status of and provide catch options for 1999 for the stocks of mackerel and horse mackerel (defining stocks as appropriate);

b) assess the status of and provide catch options for 1999 for the sardine stock in Divisions VIIIc and IXa, and the anchovy stocks in Sub-Area VIII and Division IXa;

c) provide the data required to carry out multispecies assessments (quarterly catches and mean weights at age in the catch and stock for 1997 by statistical rectangle of the North Sea for mackerel and horse mackerel) and review the time series of quarterly catch and weights at age for North Sea mackerel, western mackerel, North Sea horse mackerel and western horse mackerel used by the MAWG in Doc. ICES CM 1997/Assess:16, suggesting and documenting any necessary revisions to those series;

d) consider the reference points proposed by the SGPAFM, adopting those reference points or presenting alternatives with reasons for the alternative selection;

e) consider the harvest control rules proposed by the SGPAFM, taking into account uncertainties in the data, in the assessments and in the biological processes, and assuming a stock-recruitment relationship, to estimate the probability of avoiding limit reference points;

f) update information on quantities of discards by gear type for the stocks and fisheries considered by this group using the format proposed by the WGECO with a view to establishing a time series;

g) quantify changes in sardine and anchovy recruitment in the Iberian region and the Bay of Biscay and investigate possible relationships between any environmental parameters available and indices of recruitment.

In response to an additional term of reference received by ICES from NEAFC, the Working Group was also asked to:

h) collect and evaluate the available data on the area distribution of mackerel in the NEAFC area for juvenile as well as parental components and advise NEAFC on what further research is needed in order to give a comprehensive description of the distribution and possible technical interaction.

1.2 Participants

Pablo Abaunza	Spain
Sergei Belikov	Russia
Maria de Fátima Borges (Part Time)	Portugal
Pablo Carrera	Spain
Chris Darby	UK (England and Wales)
Guus Eltink	Netherlands
Svein A. Iversen	Norway
Jan Arge Jacobsen	Faroe Islands
Ciarán Kelly	Ireland
Maria Manuel Martins	Portugal
John Molloy	Ireland
Alberto Murta	Portugal
John Nichols	UK(England and Wales)
Kenneth Patterson (Chairman)	UK (Scotland)
Carmela Porteiro (Part Time)	Spain
Patrick Prouzet	France
David Reid	UK (Scotland)
Per Sparre	Denmark
Eugene Shamrai	Russia
Dankert Skagen	Norway
Eduardo Soares	Portugal

Andrés Uriarte	Spain
Begoña Villamor	Spain
Christopher Zimmermann	Germany

1.3 Report on Progress with Respect to Recommendations

The Working Group reviewed the progress which had been made in respect to the various recommendations which had been made at the 1997 meeting. This is reviewed briefly as follows.

Mackerel

The observer programme to monitor discards in the mackerel/horse mackerel fleets which had been strongly recommended has not been put in place.

The mean weights at age in the stock, calculated from Irish data, have been used together with Dutch data as the best estimates of the weights for the stock at spawning time.

Distribution patterns in the North Sea and VIa North have not been further investigated.

Mackerel egg surveys will be carried out in the North Sea during 1999.

Modelling work is currently in progress on improving the use of the juvenile surveys for recruitment predictions.

A new project on mackerel recruitment, entitled SEAMAR (Shelf Edge Advection, Mortality and Recruitment) will start on 1/1/99. This project is aimed at modelling larval survival through to recruitment. Participants are from Scotland, England, Spain, Portugal, Germany and Ireland.

Horse Mackerel

There has been no improvement in the age reading programmes carried out by countries on horse mackerel in 1997. This, however is expected to improve in 1998 as Ireland has commenced an age reading programme.

A horse mackerel age reading workshop is expected to be held early in 1999.

No further research has been carried out on North Sea horse mackerel.

Studies on the stock identity and migration patterns of Southern horse mackerel are being carried out but the results have not yet been fully analysed.

Sardine

Acoustic surveys have been carried out in 1998 but have covered the entire area recommended. This, however, is not the entire area over which the stock is distributed.

A planning group was held in relation to the acoustic surveys.

Recommendations agreed at the 1997 Workshop on Sardine Otolith Age Readings were implemented. An exchange of otoliths from the Gulf of Cadiz was arranged under the EU funded EFAN project.

Anchovy

Further studies on ageing of anchovy either by otoliths or other methods in the Gulf of Cadiz were carried out.

Coordinated acoustic surveys between France and Spain in the Bay of Biscay but no joint surveys were conducted in the Gulf of Cadiz.

Collection of information physiology of anchovy in relation to post-spawning mortality were conducted.

General

Egg Survey Working Group is expected to meet in Hamburg in April 1999.

A complete set of the relevant Working Group reports has not been made available to the Working Group as requested.

1.4 Quality and Adequacy of Fishery and Sampling Data

1.4.1 Sampling data from commercial fishery

The Working Group again carried out a brief review of the sampling data and the level of sampling on the commercial fisheries. Sampling appears to be adequate for mackerel (approx. 83% coverage of catch), sardine and anchovy but poor for horse mackerel in the western areas and in the North Sea. A short summary of the data, similar to that presented in recent Working Group is shown for each stock species. The overall sampling intensity is similar in recent years. Intensive sampling programmes continue to be carried out by Spain and Portugal. On the other hand, sampling programmes on some of the large northern fisheries, particularly horse mackerel is very inadequate. Sampling programmes in Spain, Portugal, Ireland, England, France have been supported by an EU funded programme, 94/013. The sampling programme on the various species is summarised as follows.

Mackerel

Year	Total catch (t)	% Catch covered by sampling programme	Samples	Measured	Aged
1992	760,000	85	920	77,000	11,800
1993	825,000	83	890	80,411	12,922
1994	822,000	80	807	72,541	13,360
1995	755,000	85	1,008	102,383	14,481
1996	563,600	79	1,492	171,830	14,130
1997	569,600	83	1,067	138,845	16,355

In mackerel it appears that over 83% of the total catch was covered by sampling. The overall sampling level appears to have decreased during 1997 and returned to the level of 1995. Spain and Portugal continue to carry out extremely intensive programme on their catches but Germany did not continue with their sampling programme which it had commenced in 1996. Norway and UK (Scotland) reduced their programmes but on the other hand Netherlands and UK (England) increased their programmes. Denmark only carries out sampling on their catches during the fourth quarter. There are still, however, a number of important mackerel catching countries which did not carry out any sampling programmes, e.g. Faroes, France, Germany and Sweden.

The main areas, that do not appear to be adequately sampled, are Division IIIa 8,000 t (Denmark), Division VIIIc 3,400 t (France), Division VIId 8,500 t (England). The summarised details of the more important mackerel catching countries are shown in the following table for 1997:

Country	Official Catch	Catch covered by sampling programme	Samples	Measured	Aged
Norway	137,300	100	130	11,877	1,508
UK (Scotland)	105,100	89	55	4,380	2,185
Russia	53,700	100	57	7,886	685
Ireland	53,100	99	63	11,869	4,138
Spain	46,500	100	361	5,4274	2,671
UK(England) Wales)	43,800	58	53	12,513	2,129
Netherlands	23,700	100	76	6,083	1,900
Denmark	22,000	63	4	219	74
France	21,000	0	0	0	0
Germany	15,400	0	0	0	0
Faroes	11,200	0	0	0	0
Sweden	4,700	0	0	0	0
Estonia	4,400	0	0	0	0
Portugal	2,100	100	425	29,744	1,065
Others + discards	24,100	95	0	0	0
Total	568,100	0	1,076	138,845	16,355

Horse Mackerel

The following table shows a summary of the overall sampling intensity on horse mackerel catches in recent years.

Year	Total catch (t)	Catch covered by sampling programme	Samples	Measured	Aged
1992	436,500	45	1,803	158,447	5,797
1993	504,190	75	1,178	158,954	7,476
1994	447,153	61	1,453	134,269	6,571
1995	580,000	48	2,041	177,803	5,885
1996	460,200	63	2,498	208,416	4,719
1997	518,900	75	2,572	247,207	6,391

Although the overall sampling levels on horse mackerel has increased considerably in recent years there are still a number of countries that have substantial fisheries and do not carry out adequate programmes. The only countries that carried out comprehensive sampling programmes in 1997 were Netherlands, Portugal and Spain. Other countries, e.g. Ireland, Denmark and United Kingdom carry out no ageing programmes whatsoever. The lack of sampling data for large portions of the horse mackerel catch continues to have a serious effect on the accuracy and reliability of the assessment and the Working Group remains concerned about the low number of fish that have been aged during the last 4 years.

The following table shows the most important horse mackerel catching countries and the summarised details of their sampling programme in 1997:

Country	Catch (t)	Catch covered by sampling programme	Samples	Measured	Aged
Netherlands	122,684	122,684	98	1,0936	2,450
Ireland	74,250	38,835	25	3,639	0
Denmark	63,077	59,617	50	1,390	0
Norway	46,484	43,846	21	1,819	193
Spain	41,993	41,987	678	50,987	752
Germany	36,379	0	0	0	0
Scotland	32,894	0	0	0	0
Others	22,345	21,260			
England	20,047	0	0	0	0
Portugal	18,659	18,659	1,717	178,436	2,996
Total	478,812	346,888	1,717	247,207	6,391

*Includes discards, small catches by other countries, and some unallocated catches.

The sampling coverage for the various fisheries are shown below:

Catch	% Catch covered by sampling	Samples	Measured	Aged
Ireland	52.3	25	3,639	
Netherlands	100	98	10,936	2,450
Norway	94.3	4	1,819	193
Spain	100	678	50,987	752
England	0			
Spain	94.5	50	1,390	
Germany				
Portugal	100	1,717	178,436	2,996
Scotland				
Others (22,345 t)	96.8			
Total (518,882 t)	74.6	2572	24,7202	6,391

The sampling intensity for the western fisheries was as follows:

Catch	% Catch covered by sampling	Samples	Measured	Aged
Ireland	52.3	25	3,639	0
Netherlands	100	75	8,039	1,875
Norway	94.3	4	1,819	193
Spain	99.7	38	2,608	52
Denmark	94.5	50	1,390	0
Portugal	100	27	1,862	0
Others (144,273 t)	0	0	0	0
Total Catch (442,571 t)		219	19,357	2,120

The sampling intensity for the North Sea fishery was as follows:

Catch	% Catch covered by sampling	Samples	Measured	Aged
Netherlands	100	23	2,897	575
Others (8,324 t)	0	0	0	0
Total catch (19,540 t)		23	2,897	575

The sampling intensity for the Southern fishery was as follows:

Catch	% Catch covered by sampling	Samples	Measured	Aged
Spain	100	640	48,379	700
Portugal	100	1690	176,574	2,996
Total catch (56,771 t)	100	2330	224,953	3,696

Many of the important fisheries carried out throughout Sub-Areas VI and VII remain inadequately sampled and catches have to be converted to numbers at age using data based on the Dutch sampling programme. As has been pointed out many times this procedure may not be appropriate, particularly if fisheries are carried out by vessels using different gears and at different times of the year.

Sardines

The sampling programmes carried out on sardines in 1997 were again very similar to the programmes of recent years and are summarised as follows:

Year	Total catch (t)	Catch covered by sampling programme %	Samples	Measured	Aged
1992	164,000	79	788	66,346	4,086
1993	149,600	96	813	68,225	4,821
1994	162,900	83	748	63,788	4,253
1995	138,204	88	716	59,444	4,991
1996	126,926	90	833	73,220	4,830
1997	115,814	97	790	79,969	5,133

In general the overall sampling intensity remains at a satisfactory level and good coverage is maintained throughout the year. No sampling programmes are carried out by France or Denmark.

The summarised details of individual sampling programmes in 1997 are shown below:

Country	Catch (t)	Catch covered by sampling programme	Samples	Measured	Aged
Portugal	81,156	81,156	444	48,193	3,400
Spain	34,658		346	31,776	
France	14,105	0	0	0	0
UK (England)	4,907	4,830	6	683	0

Anchovy

The sampling programmes carried out on anchovy in 1997 are summarised below. The programmes are shown separately for Sub-area VIII and for Division IXa. Sampling throughout Divisions VIIb+d and VIIIc appears to be satisfactory. No sampling programme (ages and lengths) is carried out on catches (5,500 t) taken from Division VIIIa although these catches are sampled for size category.

The overall sampling levels for recent years are shown below:

Year	Total catch (t)	Catch covered by sampling programme (t)	Samples	Measured	Aged
1992	40,800	37,700	289	17,112	3,805
1993	39,700	39,700	323	21,113	6,563
1994	34,600	34,400	281	17,111	2,923
1995	42,104	35,048	?	?	?
1996	38,773	36,053	214	17,800	4,029
1997	27,440	20,966	258	18,850	5,194

The sampling programmes for France and Spain are summarised below:

Country	Division	Catch (t)	Catch covered (t)	Samples	Measured	Aged
France	VIIIa	5528	0	0	0	0
France	VIIb,d	6303	6303	61	2968	1590
Spain	VIIIb,d	3937	3937	55	2957	1089
Spain	VIIIc(east)	6072	6067	114	8034	2515
Spain	VIIIc(west)	307	0	0	0	0

Country	Division	Catch (t)	Catch covered (t)	Samples	Measured	Aged
Spain	Div. IXa	4654	4654	28	4891	0
Portugal	Div. IXa	631	0	0	0	0
Total	Div. IXa	5285	4654	28	4891	0

1.4.2 Catch data

Recent Working Groups have on a number of occasions discussed the accuracy of the landings statistics and the possibility of large-scale underreporting or species and area misreporting. These discussions applied particularly to mackerel and horse mackerel in the northern areas. This topic was again discussed by the present Working Group.

For mackerel and horse mackerel it was concluded that in the southern areas the catch statistics appear to be satisfactory. In the northern areas it was concluded that in 1996 and 1997 there has been a considerable improvement in the accuracy of the total landing figures. This is because of tighter enforcement of the management measures in respect of the national quotas and because of the increasing awareness of the importance of accurate catch figures for possible zonal attachment of some stocks. There is still, however, large-scale area misreporting of catches particularly in Areas IV, VI and VII and possibly some species misreporting. Underreporting of catches because of transshipping of catches at sea has decreased in recent years because most of the catches are now landed to factories ashore. Information on discard levels is available for only one fleet but discards may also be carried out by other fleets. Therefore the total amounts discarded may be underreported. (see Section 1.4.3 below).

1.4.3 Discards

Mackerel

Only one country (Netherlands) supplies information on discards and this information is not applied to any other fleet. There is no new information on discard levels during 1997.

Discarding of small mackerel has historically been a major problem in the mackerel fishery and was largely responsible for the introduction of the south-west mackerel box. In the years prior to 1994 there was evidence of large-scale discarding and slipping of small mackerel in the fisheries in Division IIa and Sub-area IV, mainly because of the very high prices paid for larger mackerel (>600 g). This factor was put forward as a possible reason for the very low

abundance of the 1991 year class in the 1993 catches in numbers at age. In some fisheries, e.g. those in Sub-areas VI and VII, mackerel is taken as a by-catch in the horse mackerel fisheries. Reports from these fisheries have suggested that discarding may be significant because of the low mackerel quota relative to the high horse mackerel quota - particularly in those fisheries carried out by freezer trawlers. In the fisheries carried out in Divisions IIa and IVa the difference in prices paid for small and large mackerel has decreased since 1994 and the Working Group assumed that discarding may have been reduced in these areas. The level of discards is greatly influenced by the market prices and by quota.

In autumn 1997 an EU-funded programme involving Norway and Scotland commenced with the intention of studying the performance of the purse seine fisheries for herring and mackerel. This programme which will continue over two years will provide data on discards for these fleets. The Working Group would also like to draw attention to the possibility that discarding of small mackerel may again become a problem in all areas particularly if a strong year class enters the fishery.

An EU programme carried out by Spain studied the rate of discards of all species taken by the Spanish fleets, fishing in Sub-areas VI, VII, VIIIc and IXa. The results of this study (Perez *et al.* 1994) showed that the discard rates varied by species, area and fishing fleet. The observed levels of discards were between 0.2%–25.7% for horse mackerel, between 0.1% and 8.1% for mackerel and less than 1% for sardine.

Horse mackerel

As with mackerel only the Netherlands provides information on discards in the horse mackerel fisheries. The amounts of horse mackerel discarded by the Dutch fleet represents a much smaller proportion (3%) of their total catch than in the mackerel fisheries (79%) and there appears to be no apparent reason why vessels would discard significant amounts apart from losses due to damage to nets. There appears to be no significant amounts of discarding in the Southern horse mackerel fishery but there is no data available.

Sardine

Discarding in the sardine fishery is not considered to be a significant problem but there are no estimates available.

Anchovy

As in the sardine fishery there are no estimates of discards in the anchovy fishery but there does not appear to be any significant problem.

Because of the potential importance of significant discard levels on the mackerel and horse mackerel assessments the **Working Group again recommends that observers should be placed on board vessels in those areas in which discarding may be a problem. This observer programme should be commenced as soon as possible.**

1.4.4 Age reading

The quality of the age data for the various assessments depends on 1) the accuracy and precision of the age readings of each species, and 2) the sampling intensity which enables the catches to be converted into numbers at age. The Working Group examined the various species with respect to these factors. Factor 1 is dealt with in this Section, but factor 2 is dealt with in Section 1.4.1.

Mackerel

A mackerel otolith exchange in 1994 showed that the ageing was of a poor quality. Therefore an otolith workshop was held in February 1995 (ICES 1995/H:1). This improved the quality considerably, and the Working Group now has more confidence in the precision of the age readings.

Horse Mackerel

A horse mackerel otolith exchange was carried out in 1996. The results showed that there is a considerable bias in the age readings. The results of the exchange are described in ICES (1998/Assess:6) and in Eltink (1997).

As in recent years, the only countries carrying out age readings on otoliths of horse mackerel are the Netherlands, Spain, Portugal and Norway. For the western area the catches of the non-sampling countries use the age compositions of either the Netherlands or Norway (only for the Divisions IIa and IVa area) to raise these to their own catches. In some cases this causes serious problems, e.g. where in a certain area/period the Netherlands took only one sample because of low Dutch catches and the Dutch age composition was then raised to the high catches of non-sampling countries. The quality

of the catch in numbers at age would improve considerably, if the non-sampling countries, with relatively high catches would start to age horse mackerel and would take samples for ageing relative to their catches. It is therefore extremely important that countries like Ireland, Denmark and the United Kingdom should initiate ageing programmes immediately. The text table below shows how the number of otolith readings relates to the catches by country for all areas in 1997. The position is little changed from that reported for 1996 (see Section 4.7).

Country	Catch (t)*	Otoliths read
Netherlands	122,700	2,450
Ireland	74,200	0
Denmark	63,100	0
Portugal	18,700	2,996
UK	52,900	0
Norway	46,500	193
Spain	42,000	752
Germany	36,400	0
Others	22,300	0

*This includes discards.

The Working Group, once again, strongly recommends that all countries with relatively high horse mackerel catches should sample for age at an adequate level.

Sardine

In 1997, a Workshop on Sardine Otolith Age Reading was held in IEO, Vigo (Spain), following the sardine otolith exchange between Spain and Portugal carried out during 1996. Otolith samples collected in different areas and seasons off the Atlantic-Iberian coasts were analysed. It was concluded that there was a general good agreement between readings of the different readers involved and that the readings of the Spanish reader, who is responsible for the age length keys, were the most consistent. There was also a reasonably good agreement between those readings and the readings made by the most experienced Portuguese readers.

This Workshop produced several recommendations aiming at improving the age readings and also adopted a protocol with the criteria for the standardisation of sardine age determination. It was also planned that this protocol will be produced as a guide which will assist all otolith readers in the future.

A further problem has arisen in the last year with the appearance of a different growth pattern in the younger age groups (0, 1). This may lead to misinterpretation of the age of these younger age groups in the future.

Anchovy

The age readings of anchovy and the age sampling of all the catches continue to appear to be satisfactory in Sub-area VIII. In Division IXa the age sampling of the catches appears to be satisfactory but there is not a well established methodology for age determination.

1.4.5 Biological data

The main problems in respect to the biological data (except age reading), which are identified by the Working Group for the various species, are as follows:

Mackerel

The proportion mature of 1-, 2- and 3-year old mackerel appears to be overestimated in the present maturity ogive. This is because first of all it is based mainly on a visual assessment of maturity stage without the necessary histological evaluation. Furthermore it is potentially biased by disproportionate sampling in nominally adult and juvenile areas.

The sampling for adult parameters during the 1998 egg surveys included a strategy to ensure that a new maturity ogive, based on fish in both juvenile and adult areas, and with histological evaluation, can be produced. These new data will be available at the next Mackerel and Horse Mackerel Egg Working Group meeting in April 1999.

Horse mackerel

The selection of an appropriate maturity ogive for the western horse mackerel stock still presents major difficulties. This affects the accuracy of the assessment. As in the case of mackerel above, sampling targeted at resolving this problem was carried out during the 1998 egg surveys and will be available in April 1999.

There exists uncertainty about the level of natural mortality (ICES 1998/Assess:6).

Sardine

The maturity ogive is decreasing to older ages, a feature which seems to be generated by problems in sampling for maturity.

Anchovy

The main biological problems for anchovy lies in understanding the migration of 0-group fish and their pre-recruit distribution. Information is also required about variations in natural mortality (M) as M may increase dramatically immediately after spawning has been completed. A better understanding is needed of seasonal growth in weight and length to modulate the time evolution over time of cohorts, because of the large seasonal changes in growth. The input of hydroclimatic conditions on the recruitment success needs to be better understood since the physical conditions strongly affect the strength of the recruitment.

1.5 Progress Report from the Mackerel and Horse Mackerel Egg Survey Working Group

1.5.1 Historic data series

Plankton surveys, targeted at mackerel and horse mackerel eggs, have been carried, out on a triennial basis, in the western area since 1977. They were initially set up to provide an estimate of the spawning stock size of the western mackerel in the absence of time series data from the fishery on which to base a standard assessment. This was at a time of rapid growth in the exploitation of the stock with catches increasing from a few thousand tonnes annually to over 400,000 tonnes in 1975. This was set against the background of the dramatic collapse of the North Sea mackerel fishery in the early 1970s. The surveys, initially designed to cover the spawning of mackerel, also provided information on the spawning of horse mackerel. They have also been used to provide an estimate of the spawning stock biomass of horse mackerel since 1987 with back calculations made to the 1977 survey.

Over the twenty-one year period of the surveys changes have been made in the way the surveys are carried out and the data analysed. Changes in sampling procedures were comprehensively documented in the report of the Mackerel and Horse Mackerel Egg Production Workshop (ICES 1994/H:4). Changes have also been made in the sampling, analysis and interpretation of data on fecundity, maturity and sex ratio of both species. Many of the changes have resulted from related research projects which have provided new knowledge of the biology of both species.

As a result of the changes to egg production estimates and to adult parameters, retrospective changes have been made to the estimates of SSB of both species. These changes have been made, either by the Egg Working Group and endorsed by the assessment Working Group, or as a result of decisions made by the assessment Working Group. They are listed in Table 1.5.1.1 (mackerel) and Table 1.5.1.2 (horse mackerel). The reasons for those changes are best explained by detailing the major factors which have contributed to them.

a) Sex ratio

Mackerel:

Observations made during the 1977 surveys suggested a sex ratio of 1:1.64 females to males. This was not supported by further investigation and the expected ratio of 1:1 was eventually used for the 1977 and all subsequent surveys.

Horse mackerel:

A sex ratio of 1:1 is used.

b) Interpolated rectangles

Protocol permits an interpolated value to be used for an unsampled rectangle where there are two or more adjacent sampled rectangles. For the 1977 survey the interpolated value was calculated using the geometric mean of all adjacent

rectangles including those diagonally adjacent. In 1993 the Assessment Working Group (Anon. Assess:19) recommended the use of the arithmetic mean instead of the geometric mean.

Mackerel:

Corrections, using the arithmetic means, were made back to the 1983 survey. Corrections were not possible for the 1977 and 1980 surveys because some of the individual rectangle data were missing.

Horse mackerel:

Corrections, using the arithmetic means, were made back to the 1989 survey only.

c) Potential Fecundity

Mackerel:

For the 1977 to 1986 surveys the observed fecundity in 1986, of 1,457 eggs per gram female, was used. A new fecundity estimate was made for 1989 of 1,608 eggs per gram female. (ICES 1990/H:2). This was significantly different from the previous estimate and was used as a separate value. New estimates were also made in 1992 (1,569 eggs per gram female) and in 1995 (1,473 eggs per gram female). The Egg Working Group (ICES 1997/H:4) did not consider these values to be significantly different and used a mean value for 1992 and 1995. The whole question was re-evaluated at the Assessment Working Group in October 1997 (ICES 1998/Assess:22). It was decided that where valid individual estimates of potential fecundity were made in an egg survey year, then those individual estimates should be used. For the years 1977 to 1983 where no estimates were made, the mean of the observed values for the years 1986, 1989, 1992 and 1995 of 1,526 eggs per gram female would be used. This mean figure would not be further updated as new observations are made in the future.

Horse mackerel:

In 1987, when the estimate of egg production was first used to calculate a SSB, the only available data on fecundity were from Nazarov (1977) for the Celtic Sea area. Observations by Eltink and Vingerhoed (1989) in 1987 and 1988, in the western area provided an estimate of 1,655 eggs per gram female which was used retrospectively in 1989. New observations in 1992 (1,454 eggs per gram female) were initially applied to the 1992 survey only and then combined with previous estimates to produce a mean fecundity of 1,589 eggs per gram female. The reasons for combining the observations was that this provided a better coverage of the length distribution.

d) Atresia

Mackerel:

Following detailed research into the spawning biology of mackerel it was recommended by the 1993 Working Group that a correction be made to the potential fecundity figure to take account of the number of atretic oocytes observed. An observed value of 8.8% atresia was accepted and applied retrospectively to the potential fecundity figures to give a series of realised fecundity values. Further research suggested that the value of 8.8% was an underestimate and a new figure of 10.2%, the mean of observations in 1992 and 1995, was used retrospectively from 1995. The Egg Working Group (ICES 1997/H:4) found significant differences between years. It was subsequently agreed (ICES 1998/Assess:19), that the individual values for the observed years 1989, 1992 and 1995 should be used and that for the earlier years the mean of the observed values would be used. As in the case of fecundity, this mean figure will not be further updated as new observations are made in the future.

Horse mackerel:

The supporting research on atresia in horse mackerel is not as extensive as that for mackerel. A value of 10% for atresia was first applied, retrospectively, to the estimates of SSB in 1993. Observations in 1995 confirmed that this value was too high and the new value of 3.4% was applied retrospectively in 1996.

e) Other factors

Mackerel:

The second period egg survey in May 1980 produced an exceptionally low value which gave a total egg production of 1.48 x 10^{15} stage 1 eggs. This was rejected by the Egg Working Group in 1984 (ICES 1984/H:3) and the resultant egg production used was 1.84 x 10^{15} stage 1 eggs. A review of the problem was carried out by the Egg Working Group in 1993 (ICES 1993/H:4). No new evidence could be found for rejecting the second survey point, in spite of evidence that the lower egg production produced a better fit to the historic VPA data set. The Assessment Working Group revisited the problem (ICES 1995/Assess:2) and recommended that the third survey data point, and the resultant lower egg production and SSB, be used in future. Currently both values are published in the data table.

In 1989 the first survey period generated a very high production value of 2.22 x 10^{15} stage I mackerel eggs. It was subsequently found that the standard sampling strategy had been seriously violated on that survey. It was concluded that the violation had generated the abnormally high value and that it should be rejected. The resultant estimate of seasonal egg production was 1.41 x 10^{15} stage 1 eggs.

Some small errors were generated when the egg survey data base was transferred from Lowestoft to Aberdeen in 1993. These affected the egg production estimates for the survey years 1986 and 1989 only.

Minor changes have been made to the egg production estimates in 1983 and 1986 and 1995 by the inclusion of survey data from outside the designated standard area in that year.

Horse mackerel:

When the estimates of horse mackerel egg production were first used to calculate SSB, in 1987, some of the survey data were not then available. These data were added in 1988 and generated significant increases in the estimates of egg production and SSB.

The problems generated for mackerel egg production by the first survey in 1989 were also applicable to horse mackerel. The survey data were therefore not used.

1.5.2 The 1998 egg survey

The egg surveys of the western and southern areas were successfully carried out, over the period January to July, according to the plan agreed at the planning meeting in Lisbon in 1997 (ICES 1997/H:4). The number of sampling periods had to be reduced from seven to six, to match eventual availability of survey vessels.

Preliminary results from the western area only show that the surveys successfully covered the spatial distribution of horse mackerel spawning but the peak of stage 1 egg production occurred on the final survey.

The temporal distribution of mackerel spawning in the western area was well covered but spatially the western boundary, north of the Porcupine Bank, and the northern boundary was not well established in the sampling periods 4 and 5.

The surveys began in the southern area on 17 January with Portugal surveying the whole area from 36°N to 43°N up to 31 January. In the second period, starting on 8 February, Portugal fully sampled the area from 37°45'N to 43°N but poor weather prevented sampling to the south of that area. A further coverage of the area south of 43°N by Portugal from 22 to 28 February was severely hampered by bad weather and a large area at the south-western corner south of 38°N was not sampled.

Spain surveyed the area from 43°N and along the Cantabrian coast in period 3, from 13 March to 1 April, achieving a good coverage, with the exception of five unsampled rectangles at the western edge of the standard area. Sampling in the southern area in period 4 began on 7 April and ended on 28 April. Spain experienced serious delays due to poor weather during this period. A total of 20 rectangles at the northern, western and eastern edges of the standard area were not sampled. Planned coverage by Spain (IEO) into the southern end of the western area in period 4 had to be abandoned. Sampling in the southern area, north of 42°N in period 5, was carried out by Netherlands and Spain (AZTI) and in period 6 by England.

Provisional plots of the abundance of mackerel and horse mackerel eggs, off Galicia and in the Cantabrian Sea, were provided by Spain (IEO) for periods 3 and 4. Data from the other participants have not yet been fully analysed and no provisional estimates of egg production were available at the Working Group.

Sampling targets for the adult parameters (fecundity, atresia and maturity), in the southern area, were satisfactorily achieved by Spain (IEO) for both species. For mackerel atresia 19 samples (258 fish), for maturity 13 samples (347 fish) and for fecundity 2 samples (69 fish) were taken. For horse mackerel atresia 19 samples (281 fish), maturity 14 samples (376 fish) and for fecundity 11 samples (123 fish) were taken. Most of the sampling targets for mackerel and horse mackerel adult parameters were met by Portugal, with the exception of mackerel maturity targets which were under-sampled in the nominal juvenile areas.

The surveys began in sampling period 3 on 15 March with good coverage of the standard area, from 44°N to 53°N, by Germany with 28 duplicate samples, south of 46°N, taken by Spain (IEO). Sampling in period 4 was carried out by Scotland and The Netherlands from 16–30 April with a full coverage of the standard area. Because of poor weather in the south, Spain (IEO) was unable to sample in the western area during period 4. The planned samples were taken by the Netherlands instead. Sampling, targeted at the expected peak spawning for both species, in period 5 (26 May–13 June) was shared between The Netherlands, Norway, Ireland, England and Spain (AZTI). Sampling in the final period from 14 June–5 July was carried out by Ireland Scotland and England.

Sorting identification and staging of mackerel and horse mackerel eggs was carried out on board ship during the surveys by Scotland, Germany and Norway. Data from those countries, together with the data from Ireland, have been fully worked up and were available as numbers of stage 1 eggs produced per day, for preliminary analysis at this Working Group. The Netherlands sorted plankton samples on board ship and provided most of their data, fully worked up, to the Working Group. All the sample data from period 5 and some of the western area data in period 6, taken by England, were also available for preliminary analysis. The data from Spain (AZTI) were not available.

A provisional estimate was made of egg production in the western area, based on the incomplete data set, and is reported for mackerel in Section 2.5.2 and for horse mackerel in Section 6.3.

All fecundity sample collection targets in the western area were met for both species, the samples have been distributed between SOAEFD and CEFAS but have not yet been fully processed.

Samples for the estimation of atresia in both species have been taken in all periods but the samples from Spain, Norway have not yet been delivered to CEFAS for processing.

Only three of the ten planned histology samples (100 fish each) were collected for the estimation of the mackerel maturity ogive. Two of those were from offshore, nominally adult areas and one from a nominal juvenile area. Some additional observations of mackerel maturity were made by Norway but no samples were taken for histological screening. A total of 14 samples were taken for the estimation of horse mackerel maturity but the designated juvenile areas were under sampled compared with adult areas.

1.6 Quality Control Procedures

The topic of quality control was discussed and it was noted that a comprehensive assessment of this topic was outside the resources of the Working Group. As a contribution in this area, however, the Working Group decided to review its procedures for collection and maintenance of national catch, catch sampling and age-structured information.

Primary responsibility for the accuracy of national biological data lies with the national laboratories that submit such data. Data co-ordinators have the responsibility for combining, collating, and interpolating information where necessary. A number of validation checks will, however, be made by the co-ordinators (using suitable software which will be developed intersessionally) who will in the first instance report anomalies to the laboratory which provided the data. When reports of catches without accompanying sampling information are provided, it would be helpful to provide an indication of what data could be used as representative of these unsampled catches. Information on stratification should also be provided.

The Working Group endorses the procedures recommended in the draft 'Code of practice for data handling by assessment working groups' prepared by the Study Group on Future Requirements for Fisheries Assessment Data and Software. The Working Group's approach to implementing these recommendations is that:

- An existing spreadsheet used for national data submissions will be developed further to:

  (1) build in internal consistency checks,
  (2) add a macro facility to export data in a standard format,
  (3) be fully protected except for data entry in specified cells.

- The standard long-term data storage should be in an agreed ASCII format as specified in Patterson (WD 1998). Allocations of unsampled catches to age-distributions for calculating total international catches at age and weights at age will be made as described therein. Age distributions should always be stored together with the relevant information on sampling intensity.

- ICES is requested to provide a secure long-term electronic data storage facility to allow the Working Group to build a long-term database.

- Where possible, species-specific data validation and range-checking will be implemented in appropriate software.

- Compiled and documented programmes (and not spreadsheets) should be used in the preparation of standard tables of biological information for assessment purposes.

For anchovy, a complex method of catch sampling based on stratifying by commercial size-categories is used. Because of this, the software system described above is not suitable for this species and an alternative system should be developed.

The Working Group will document sampling coverage of the catches in two ways. Sampling effort will be tabulated against official catches by species (as in Section 1.4). The Working Group also suggests that plots of cumulative sampling effort on cumulative catch (accumulated across the area, time and Sub-Divisions which are used as data reporting units) can be used as a qualitative guide to the effectiveness of sampling effort. Examples are given as Figures 1.6.1. and 1.6.2. In such plots, an appropriate sampling scheme would generate roughly a straight diagonal line. From Figure 1.6.1 it can be seen that a relatively greater sampling effort for NE Atlantic mackerel is applied to smaller catches. When this is examined by quarter (Figure 1.6.2) it can be seen that relatively large catches which are not sampled for age occur in the latter half of the year.

At ACFM's suggestion, the Working Group will provide an assessment summary for each of the stocks in the proposed format.

1.7 Fleet Descriptions

Denmark

Information on the Danish fleet will be provided in next year's Working Group report.

England and Wales (UK)

The pelagic fleet of England and Wales is small and the effort has remained relatively unchanged over the past ten years. The majority of the landings are by three midwater freezer trawlers, two purser/trawlers and five vessels using either a single or a paired mid-water trawl.

The **freezer trawlers** and **purser/trawlers** range in length from 44 to 92 metres and have an engine power of 2300–6500 HP. They account for over 90% of the pelagic catch, fishing in the seasonal fisheries open to them for herring, mackerel, horse mackerel and pilchard in area VI, the North Sea and to the west of Ireland. Most of their catches are landed outside the UK.

The five **mid-water trawlers** range in size from 11 to 14.5 metres and from 200 to 300 HP. They fish mainly for mackerel and pilchard in Division VIIe. There is a very large fleet of between two hundred and three hundred **hand liners**. The majority of these vessels are less than 10 metres in length. They fish almost exclusively for mackerel in the permitted handline fishery inside the SW of the England mackerel box. Their numbers increased to the present level in the early 1990s and have remained stable since then. They account for 4% of the England and Wales mackerel catch.

Faroe Islands

The Faroese **purse-seine fishing fleet** has been rather stable in number since the late 70s, with about 10 vessels. There have been a couple of new vessels bought which have replaced older vessels, and the others have installed new and more powerful main engines, sometimes with an additional segment (10 m) inserted into the vessel to increase the holding capacity. At present 10 vessels are operating (1500–6000 HP).

They fish traditionally for capelin, blue whiting, herring, mackerel and horse mackerel in their traditional fishing areas (west of Ireland/UK, North Sea, Faroes, Iceland, Norwegian Sea, Norway, Jan Mayen, Barents Sea, and Svalbard). The strategy has been to fish for whatever fish catchable with purse-seines in a fishery characterised as an opportunistic seasonal fishery.

France

The French fleet for pelagic fishes can be divided in two parts: an **industrial** one, comprising 3 pelagic trawlers (ca. 70 metres length) fishing for herring, mackerel and horse mackerel mainly in Division VII, together with the Dutch fleet, and an **artisanal** one, comprising about 150 boats fishing anchovy, mackerel, horse mackerel and sardine mainly in the Bay of Biscay and the Channel. The artisanal fleet consists of less than 20 purse-seiners, located in the Basque Country and in Southern Brittany, and pelagic trawlers fishing in pairs, generally located in the Northern part of the Bay of Biscay and in the Basque Country.

Germany

Due to the total ban of the North Sea herring fishery in the late 70s and the beginning of the 80s Germany started a limited mackerel fishery in areas west of the British Isles.

The former numerous German trawler fleet declined in the 80s. After the reunification of the former German Democratic Republic (GDR) with the Federal Republic of Germany (FRG) in 1989 some aged **stern trawlers** from the GDR joined the fleet and increased the numbers to 17 (freezing capacity ca. 30 t/day). In the following years some of them went out of service and only a couple of stern-trawlers of the former FRG-fleet took part in the mackerel fishery in peak season as a consequence of an improved economic situation within the fishing company. From 1988 onwards, the pelagic fleet was partially replaced by four **large freezer trawlers** fishing exclusively pelagic species. They have daily freezing capacities of 120–280 t, and were mostly financed by Dutch funds. These new ships and considerable developments in catching techniques and material (larger nets, increase of engine power etc.) led to a complete achievement of the official mackerel quota in the last couple of years.

Until the mid-80s there was almost no interest in Horse Mackerel in Germany. As a compensation for decreasing herring and mackerel catches in the ICES area since 1990, horse-mackerel catches increased, especially in SA VI and SA VII.

An overview over the development of the German pelagic trawler fleet is given below:

year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
no. pelagic trawlers	1	1	1	2	4	4	4	4	4	4
GRT	4500	4500	4500	7721	11918	12050	12050	12050	18264*	18264*
no. other trawlers	10	10	10	17	17	14	14	13	11	8
GRT	20285	20285	18402	32003	31024	28211	25670	24024	20357*	17437*

(* since 1996 gross tonnage)

Ireland

The Irish pelagic fleet, which specialises in fishing for mackerel, horse mackerel, atlanto-scandian herring and blue whiting, is mainly based at Killybegs on the Northwest coast. The number of vessels in this fleet is 23. This number has increased in recent years with the addition of approximately 6 small vessels to the mackerel and horse mackerel fisheries. All vessels, with the exception of one **factory ship**, are **refrigerated sea water vessels** (R.S.W.) and use either pair or single pelagic trawls. The engine power of the tank vessels range from 860–3350 kW, average 2014 kW. The length range from 32m–65m, average 43 m. The factory trawler has 5850 kW with a length of 98 m.

New vessels are now concentrating on speed, rather than capacity, with the object of delivering better quality catches to the most lucrative markets. Vessels have continually increased the size of nets and their manoeuvrability in recent years and this, together with new sonars, has had an extremely important influence on catching efficiency.

All vessels fish under quota restrictions and for mackerel each vessel has an individual quota per week. Restrictions may shortly be in place on number of days permitted at sea. Closed seasons are also in operation. The target species for this fleet depends very much on the quotas and markets. Vessels may often change target species during the year. All vessels fish for mackerel during the open seasons in Divisions IVa, VIa, VIIb and VIIj. Fish are landed in Norway, the Faroes, Scotland and Ireland. The factory trawler fishes throughout Areas VI, VII and Division IVa, and lands mainly into Germany.

Most of the horse mackerel catch has been taken during Quarters 3 and 4 from the inshore waters in the southern part of Division VIa and from VIIb, by the smaller tank vessels. In recent years the areas from which catches have been taken have expanded (Division VIIj, southern Division of Area VII, e.g. VIIe,f,g). Most of the catch is landed in Ireland for the Japanese market.

Netherlands

The Dutch fleet on pelagic fish can be divided in two types of vessels, that use pelagic trawls: Vessels landing frozen fish: "Freezer Trawlers", and Vessels landing fresh fish: "Cutters". The description of the fleet is given by type of vessel.

Freezer Trawlers. In 1997 the number of freezer trawlers was 14, having a mean length of 95 m and a mean engine power of 6100 HP. 72% of the total catch was taken in EU waters, while 28% was caught near west Africa. In EU areas in 1997 51% of the pelagic catch consisted of horse mackerel, 18% of herring, 16% of mackerel, 9% of blue whiting and 2% of greater argentine. Another 9 Dutch owned freezer trawlers sail under foreign flags (2 English, 4 German and 3 French).

In the period 1988–1997, the number of ships remained the same, but the catch almost doubled (200,000 t to nearly 400,000 t). During the period 1988–1991 there was a fishery off Morocco, the US east coast and the Falklands. From 1994–1996 there was a fishery off Namibia, and from 1996 onwards an increasing fishery off Mauritania is developing for the largest trawlers. In 1995 a new type of side-scan-sonar was introduced, which improved fish detection considerably. In 1996 light pelagic trawl doors were used for catching fish near the surface.

Cutters. In 1997, 2 ships used pelagic trawls separately and 6 ships acted as pair trawlers. In summer cutters are beamtrawlers fishing for plaice and sole. In that year the number of cutters was 8, having a mean length of 40 m and a mean engine power of 1842 HP. The total catch was taken in EU waters and consisted of 72% herring, 12% horse mackerel and 9% mackerel. During the last 10 years the number of vessels decreased as well as the catch (33,000 t to 12,000 t).

Norway

The Norwegian vessels fishing for mackerel are divided into two main groups; smaller and larger than 23.45 m (70 ft). The **smaller boats** have to be registered as mackerel vessels but have no individual vessel quota. They are fishing on a shared quota which has been 20,000 t in several years. This quota was increased to 30,000 t in 1998. These vessels fish with hand lines, gill nets and purse seines.

The group of **vessels larger than 23.45 m** consists of some trawlers which have a total yearly quota of 3,000–5,000 t, and about 100 larger purse seiners. The purse seiners take the main part of the catches. Their share of the quota is the Norwegian TAC for the actual year minus the fixed quotas for the smaller vessels and the trawlers. All the purse seiners are fishing according to individual quotas which are related to the size of the vessel. The purse seiners are fishing directly for mackerel, horse mackerel, herring, capelin and sprat. Some of them are also equipped for blue whiting trawling.

Portugal

The Portuguese fishing fleet operates mainly in the Portuguese EEZ. Vessels can be classified into three types: **artisanal** (also called polyvalent), **purse-seiners** and **trawlers**. The first type uses different types of gears, such as small seine nets, gill-nets, hook and line, traps and small trawls. Most vessels can use several of these gears simultaneously, and they are usually of very small dimensions (length of 3–20 m, average engine power of 17 kW). The trawlers and purse-seiners are usually larger vessels (above 20 m length, 200/500 kW) which operate only with one kind of gear.

The development of the number of vessels by gear in the mainland and islands show a decrease in all types of vessels until 1995 in the mainland. Numbers of artisanal boats reduced from 11,467 to 9,172, numbers of purse seiners from

260 to 190 and numbers of trawlers from 148 to 114. In the last 2 years the numbers remained more or less stable. In Madeira and the Azores the number of vessels in all gears remained stable during the period considered.

Changes in the main target species were not reported for this period. The main target species are sardine, horse-mackerel and hake.

Russian Federation (Russia)

The fishery on pelagic fish, including mackerel, is conducted by freezer trawlers which use exclusively pelagic trawls. The Russian fleet operating in the Norwegian Sea consists of two types of vessels: **Large vessels** with a length range of 83–120 m, with an engine power of 2000–7200 HP, and **middle-sized vessels**, ranging from 59 to 62 m length, equipped with engines of 1320–2400 HP. In summer 1997 the fleet comprised 38 large and 9 middle-sized trawlers.

Russian vessels fish in a directed fishery for post-spawning mackerel migrating to the Norwegian Sea (ICES Sub-areas IIa, IVa, Vb) for feeding. They also catch mackerel and horse mackerel as by-catch in the blue whiting and herring fishery. The major part of mackerel catches was taken in Sub-area IIa in international waters. Over the last ten years the total amount of vessels decreased by approx. 50%, but the share of large vessels increased (from 53 to 83%). The yield of mackerel increased from 27.9 to 53.7 thousand t over the last decade.

Scotland (UK)

During 1986–1996, the overall number of vessels in the fleet has fallen from 58 to 46. Generally there has been a decrease in the numbers of vessels less than 49 m accompanied by an increase in the numbers of vessels over 50 m. The catching power of the fleet has also increased along with vessel size. The number of vessels using the purse seine has declined from 46 in 1986 to only 29 in 1996. From about 1991, there has been an increase in the numbers of single vessels over 50 metres using the pelagic trawl (see following table).

The main target species for the Scottish pelagic fleet in the period 1986–1997 were herring and mackerel in areas VIa and IVa. However in 1997, landings of blue whiting and horse mackerel increased considerably. Preliminary data for 1998 indicate that this trend is likely to continue.

	Year	1986		1987		1988		1989		1990		1991		
	Gear	PPT	PSE	PPT	PSE	PPT	PSE	PPT	PSE	PPT	PSE	PPT	PSE	SBPT
>50m	No vessels		6		9		11		10		10		5	4
	Av Power kw		1445		1660		1664		1704		1805		1326	1970
Total	No vessels	12	46	7	47	6	46	13	47	11	47	11	40	4
	Av Power kw	414	925	356	1063	405	1103	426	1218	489	1259	475	1276	1970

	Year	1992			1993			1994			1995			1996		
	Gear	PPT	PSE	SBPT	PPT	PSE	SBPT	PPT	PSE	SBPT	PPT	PSE	SBPT	PPT	PSE	SBPT
>50m	No vessels		7	4	2	4	3	3	5	4	1	3	8	1	11	7
	Av Power kw		1566	2114	1514	2014	2138	1589	1721	2223	1558	1795	1883	2280	1327	2591
Total	No vessels	8	39	4	9	37	3	10	35	4	8	24	10	10	29	7
	Av Power kw	554	1234	2114	761	1338	2138	834	1290	2223	768	1300	1735	898	1206	2591

PPT=Pelagic pair trawl, PSE=Purse seine, SBPT=Single boat pelagic trawl

Spain

In the ICES area a considerable part of the Spanish fishing fleet is fishing close to the littoral, although they sometimes work at some distance from the coast. This multispecies fishery is exploited by several fleets. A seasonal exploitation, depending on the presence and abundance of species throughout the year, is characterising it.

The fishery is characterised by their seasonal nature and their exploitation depends on the presence and abundance of species throughout the year. This holds especially true for the pelagic fishery, the so-called 'costeras'. This fleet can be divided into several sections. Their share of the total catch highly depends on the season as well as the geographical region.

Purse-seine fleet: its main target species are anchovy and sardine. Almost 100% of the catch of these two species is obtained by this fleet, which also catches horse mackerel and mackerel though always in relation to the availability of the target species.

Hand-line fleet: this fleet is aimed at mackerel from March to May in Sub-division VIIIc East and the Spanish part of Division VIIIb.

Trawl fleet: The trawl fleet targets demersal species, but catches pelagic species associated with them, mainly horse mackerel and, in small quantities, mackerel. In the Gulf of Cadiz some trawlers also catch anchovy eventually, when the abundance of other demersal species of interest to the fleet falls. The trawl fleet uses different bottom trawls ('baca', 'bou' and pair-trawl), 'baca' being the most widely used gear.

Gillnet fleet: this fleet targets demersal species and catches horse mackerel and mackerel in small quantities.

Artisanal fleet: consists of vessels of very small size, which have a wide variety of gears, mainly different gillnets and hand-lines, which catch species on rocky bottoms.

During the last 5 years (there are no homogeneous data available prior to 1993), the purse-seine fleet has decreased its number of vessels (from 261 to 226) and increased the mean power (from 403 to 440 HP) in Sub-division VIIIc East. The number of trawlers was reduced significantly in SD VIIIc East and West (45 to 34 and 61 to 44, respectively). In Sub-division IXa South, there is an increase in the number of purse-seine vessels in the last two years, while in the multi-purpose fleet the number of vessels and mean engine power has reduced. The fleets in all other areas showed some fluctuation, but were more or less stable. The following table summarises the structure of the Spanish fleet fishing for pelagic species in 1997:

Sub-division	fleet type	n vessels	mean length (m)	mean engine power (HP)
VIIIc East	Artisanal	583	7	47
	Gillnet	38	13	144
	Hook	304	12	136
	Purse seiner	226	23	440
	Trawl	34	23	425
VIIIc West	Artisanal	1311	6	28
	Gillnet	67	14	152
	Hook	239	16	214
	Purse seiner	107	14	194
	Trawl	44	26	516
IXa North	Artisanal	6027	5	22
	Gillnet	1	9	51
	Hook	152	20	358
	Purse seiner	187	13	176
	Trawl	105	24	435
IXa South	Multi purpose (Trawl+Artisanal)	54	11	134
	Purse seiner	79	14	257

1.8 Future Research

The Working Group is aware that a number of research programmes are being carried out at different laboratories which may in the immediate future be of assistance to the various assessments. It is important that the results of these investigations should be made available as soon as possible to the Working Group and that the Working Group should be kept informed of the progress in these programmes.

Some of the programmes which are of particular interest are:

- The exploratory fishing programmes being carried out on chartered commercial vessels by Faroe Islands, Norway and Russia that are aimed at obtaining information on the summer distribution of mackerel throughout Sub-areas V and II.

- The programmes, being carried out by Russia, using commercial aircraft and information from satellites, on the migrations of mackerel shoals.

- The final results of the EU-funded mackerel tagging project.

- Investigations being carried out by CEFAS and AZTI on the relationship between environmental conditions (water temperature and wind speed and directions) and recruitment.

- Discard levels of mackerel in the purse-seine fleets are being studied in a joint Norwegian, UK (Scotland) programme.

- Norwegian studies on genetic differentiation of Atlantic spawning stocks of mackerel are continuing.

- A new project on mackerel recruitment, entitled SEAMAR (Shelf Edge Advection, Mortality, and Recruitment), coordinated by England will start on 1/1/99. This project is aimed at modelling larval survival through to recruitment.

- Scotland and Norway are planning acoustic surveys on mackerel in the fourth quarter in the Northern North Sea. These surveys may be able to produce an SSB index for mackerel for years in-between those in which the egg surveys are carried out and so could be vital in reducing the risk inherent in having an SSB value only once every three years.

- A new project (AIR CT 97-3374) is currently being carried out by the institutes of AZTI, IEO, IFREMER and IPIMAR on the ecology of juveniles of pelagic species (mainly anchovy and sardine). This project entitled "Experimental Surveys for Assessment of Juveniles" will provide a better understanding of the ecology and spatial distribution of the juveniles of these species in autumn time in Sub-areas VII, VIII and IX.

- Surveys, aimed at studying the abundance and distribution of juvenile mackerel in and around the "Cornwall Box", will be carried out by the UK in the winter of 1998/1999.

Table 1.5.1.1 a

Changes in Mackerel Stage 1 Egg production estimates $x10^{15}$							
Year	**Survey Year**						
	1977	**1980**	**1983**	**1986**	**1989**	**1992**	**1995**
1978 a	1.61						
1979 a	1.98						
1981 a		1.48					
1984 b			1.44				
1984 a	1.98	1.84	1.5				
1987 a	1.98	1.84	1.5	1.166			
1990 a					1.41/2.22		
1993 a	1.98	1.84	1.5	1.17	1.50	1.78	
1993 b	1.98	1.84	1.53	1.16	1.52	1.94	
1995 b	1.98	1.84/1.48	1.53	1.24	1.52	1.94	
1996 a	1.98	1.84	1.53	1.24	1.52	1.94	1.27
1996 b	1.98	1.84	1.53	1.24	1.52	1.94	1.31
1997 a	1.98	1.84/1.48	1.53	1.24	1.52	1.94	1.49
1997 b	1.98	1.84/1.48	1.53	1.24	1.53	1.94	1.49

a - Egg Workshop or Working Group
b - Assessment Working Group

Table 1.5.1.1 b

Changes in Mackerel SSB Estimates '000 tonnes							
Year	**Survey Year**						
	1977	**1980**	**1983**	**1986**	**1989**	**1992**	**1995**
1981 a		1.8					
1984 a		2.9	2.4				
1987 a	3.0	2.9	2.4	1.5			
1990 a					2.01/2.93		
1993 a	3.22	2.99	2.44	1.90	2.21	2.69	
1993 b	3.22	2.99	2.49	1.89	2.24	2.93	
1995 b	3.22	2.99/2.41	2.49	2.01	2.24	2.93	
1996 a	3.22	2.99	2.49	2.01	2.24	2.93	2.1
1996 b	3.22	2.99	2.49	2.01	2.24	2.93	1.97
1997 a	3.22	2.99/2.41	2.49	2.02	2.24	3.09	2.37
1997 b	3.25	3.02/2.43	2.51	2.15	2.56	2.93	2.47

a - Egg Workshop or Working Group

b - Assessment Working Group

Table 1.5.1.2 a

Changes in Horse Mackerel stage 1 egg production Estimates x 10^{15}							
Year	**Survey Year**						
	1977	**1980**	**1983**	**1986**	**1989**	**1992**	**1995**
1987 a	0.497	0.427	0.192	0.299			
1988 b	0.533	0.635	0.381	0.508			
1989 b	0.533	0.635	0.381	0.508			
1990 a					1.683		
1990 b	0.533	0.635	0.381	0.508	1.683		
1993 a	0.533	0.635	0.381	0.508	1.683	1.370	
1993 b	0.533	0.635	0.381	0.508	1.63	1.58	
1996 a	0.533	0.635	0.381	0.508	1.63	1.58	0.96
1997 b	0.533	0.635	0.381	0.508	1.63	1.58	1.226

a - Egg Workshop or Working Group

b - Assessment Working Group

Table 1.5.1.2 b

Changes in the Horse Mackerel SSB Estimates '000 tonnes							
Year	**Survey Year**						
	1977	**1980**	**1983**	**1986**	**1989**	**1992**	**1995**
1987 a	1.128	0.987	0.445	0.692			
1988 b	1.244	1.652	1.084	1.361			
1989 b	0.86	1.023	0.614	0.819			
1990 a					2.13		
1990 b	0.676	0.806	0.483	0.645	2.13		
1993 a	0.75	0.89	0.54	0.72	2.37	2.20	
1993 b	0.78	0.93	0.56	0.75	2.39	2.32	
1996 a	0.78	0.93	0.56	0.75	2.39	2.32	1.34
1997 b	0.74	0.89	0.53	0.71	2.28	2.21	1.71

a - Egg Workshop or Working Group

b - Assessment Working Group

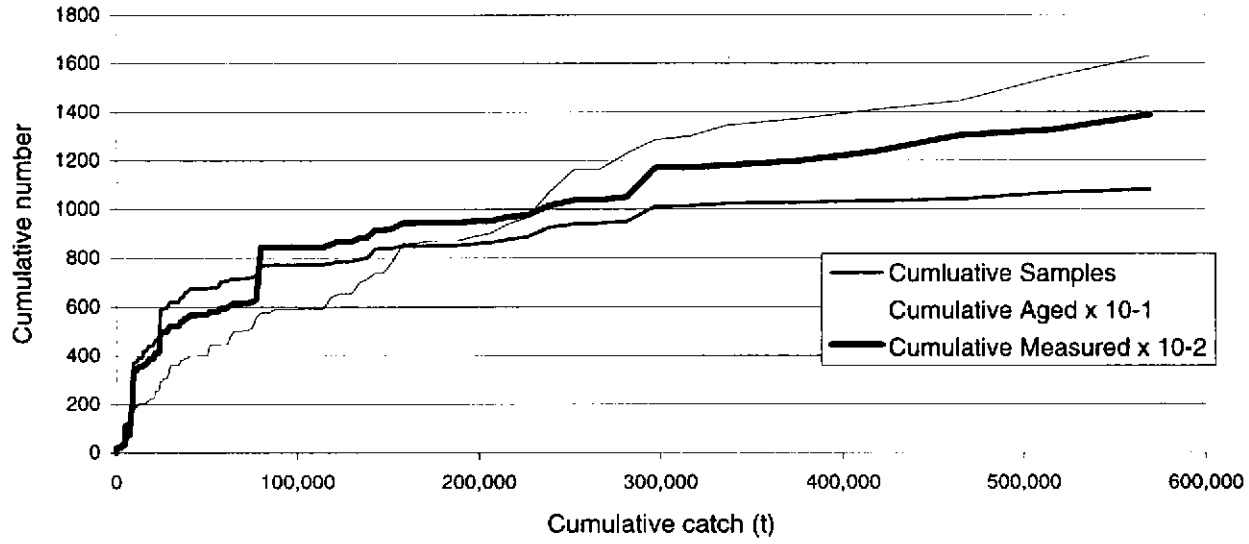

Figure 1.6.1 Sampling relative to catch for NE Atlantic mackerel ordered by increasing catch over all periods

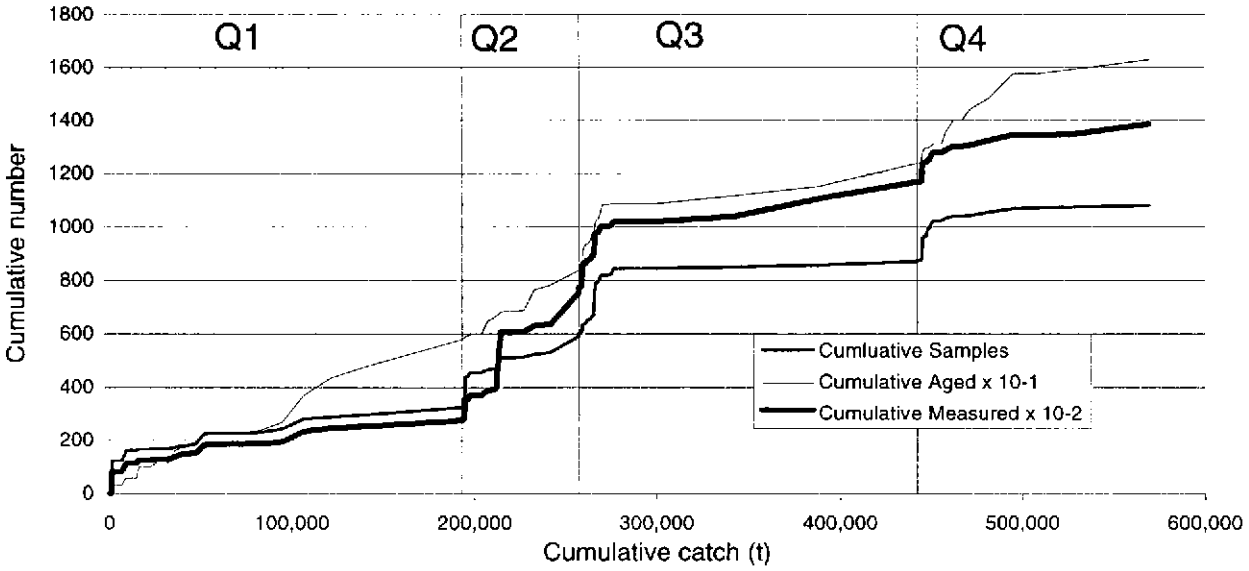

Figure 1.6.2 Sampling relative to catch for NE Atlantic mackerel ordered by increasing catch within each quarter

2 NORTH EAST ATLANTIC MACKEREL

2.1 ACFM Advice and Management Applicable to 1997 and 1998

The TACs agreed by the various management authorities and the advice given by ACFM for 1997 and 1998 were as follows:

	1997			1998	
Stock	Advice recommended by ACFM	Agreed TAC	Catch	ACFM: Highest tabulated option within precautionary range	Agreed TAC
North Sea Stock	Lowest possible level	52.8	?	LPL	52.8
Western Stock	Significant reduction in F	387.4	529[1]	478.0[1]	461.5
Southern Stock	Significant reduction in F	30	41[2]	21.0[2]	35.

[1]Assumed to be mainly Western stock mackerel, taken from Sub-area IV, Division IIIa and IIa, and included in the total agreed TAC for the western stock.
[2]Division VIIIc, Sub-areas IX and X and CECAF Division 34.1.1 (EU waters only).

The agreed TAC for 1997 for all stocks combined amounts to 470,205 t, and that for 1998 to 549,335 t. Both these figures include the agreements between EU, Norway and the Faroes, and agreements that the Faroes has with Iceland, Estonia and Russia. The agreement with Russia is a by-catch quota.

For 1997 ACFM recommended a significant reduction in fishing mortality in order to restore and maintain the SSB within the range observed in the time series available. For 1998, ACFM recommended a fishing mortality between 0.15 and 0.20, the highest tabulated F consistent with the precautionary approach was given as $0.8F_{97}$.

It is again important to stress that while the TAC options are meant to apply to the total catch of all mackerel over the total distribution area the actual agreed TACs do not apply to the catches taken in international waters. The total catches in international waters, which are mainly taken by Russia in the Norwegian Sea, have been increasing in recent years. In 1998, the Russian catch in Faroese and international waters is at the same level as in recent years. There are no restrictions on the amount of fish which can be taken in the fishery in international waters.

In addition to the TACs and the national quota the following are some of the more important additional management measures which were in force in 1997 and are again in force in 1998. These measures are mainly designed to afford maximum protection to the North Sea stock while it remains in its present depleted state while at the same time allowing fishing on the western stock while it is present in the North Sea.

1. Prohibition of fishing in Division IVa during Quarters 1 and 2, and of a directed mackerel fishery in Divisions IVb and IVc throughout the year (Norway opened for a fishery in Division IVa the first half of the year since 1996);

2. Prohibition of a directed mackerel fishery in the "Mackerel Box";

3. Minimum landing size of 30 cm for Sub-area IV, Division IIIa and 20 cm for Divisions VIIIc and IXa;

Various national measures such as closed seasons and boat quotas are also in operations in most of the major mackerel catching countries.

2.2 The Fishery in 1997

2.2.1 Species mixing

***Scomber* sp.**

As in previous years, there was both a Spanish and a Portuguese fishery for Spanish mackerel, *Scomber japonicus*, in the south of Division VIIIb, in Division VIIIc and Division IXa.

Table 2.2.1.1 shows the Spanish landings by Sub-division in the period 1982–1997. In 1997 the catch in Division VIIIb was 362 t, a fall with respect to 1996. The catch in Sub-division VIIIc East reached 4,416 t in 1997, being the highest

catch registered since 1982. In Sub-division VIIIc West the catch was 610 t, an increase with respect to 1996. In Sub-division IXa North in 1997, the catch fell (1,727 t) compared with the period 1993–1997.

Data of monthly landings by gear and area were obtained from fishing vessel owner's associations and fishermen's associations through the existing information network of the IEO and AZTI (Advisory Organisations to Fisheries and Oceanography Administration) in all ports of the Cantabrian and Galician ports. In the ports of Cantabria and Northern Galicia (Sub-division VIIIc West) catches of *S. scombrus* and *S. japonicus* are separated by species, since each of them is important in a certain season of the year. In the ports of Southern Galicia (Sub-division IXa North) the separation of the catch of the two species is not registered in all the ports, for which reason the total separation of the catch is made based on the monthly percentages of the ports in which they are separated and based on the samplings carried out on the ports of this area.

In Sub-division IXa South, the Gulf of Cadiz, there is a small Spanish fishery for mixed mackerel species which had a catch of 613 t of Spanish mackerel in 1997. In the bottom trawl surveys carried out in the Gulf of Cadiz in 1997, catches of *S. Scombrus* were scarce or even non-existent, with *S. japonicus* making up 99% of the total catch in weight of both species (M. Millán, pers. comm). Due to the uncertainties as to the proportion of *S. Scombrus* in landings, they have never been included in the mackerel catches reported to this Working Group by Spain.

In Portugal the landings of Spanish mackerel from Division IXa (CN, CS and S) were 5,408 t in 1997, more abundant in the southern areas than those of the north (Table 2.2.1.1). These species are landed by all fleets but the purse seiners accounted for 73% of total weight. Landings data are collected from the auction market system and sent to the General Directorate for Fisheries where they are compiled. This includes information on the landings per species by day and vessel.

There is believed to be little error in the identification of mackerel species in the Spanish and Portuguese fisheries in Divisions VIIIb,c and in Division IXa.

The catches of the *Scomber japonicus* are not included in the TAC of the *Scomber scombrus* for the Southern area.

2.2.2 Catch estimates

The total catch estimated by the Working Group to have been taken from the various areas is shown in Table 2.2.2.1. This table shows the development of the fisheries since 1969. The total catches per quarter sine 1990 are shown in the text table below. The total estimated catch in 1997 was about 569,500 t which was approximately 5,000 t higher than the catch taken in 1996 which was the lowest recorded from the fishery since 1973. The TACs set for 1997 for all areas for which TACs were agreed amounted to 470,205 t (See Section 2.5.1.1.) The decrease in catches during 1996 and 1997 have been mainly due to the decrease in the TACs set as a result of the international agreements and the more effective enforcement of the management measures. The corresponding TAC agreed for 1998 is 549,335 t. Estimates of discards are also shown in this table but these estimates apply to one fleet only.

During 1997 the highest catches (over 227,000 t) were again taken from Sub-area IV and Division IIIa - over 215,700 t of these having been taken in Division IVa. The catches taken from Division IIa and Divisions Va and Vb (105,000 t) where the international fisheries take place were very similar to those recorded in 1996. The overall catch taken in the fisheries in Sub-areas VI and VII and in Divisions VIIa,b,d,e was 196,000 t compared to 213,000 t in 1996. However, there was a considerable decrease in the catches from Division VIa where the catch fell from 130,000 t in 1996 to 67,000 t in 1997. This decrease was mainly recorded by Ireland (-10,000 t), Scotland (-13,000 t), France (-7,000 t), and in the unallocated catches (-9,500 t).There was a corresponding increase in the catch in Division VII where the catch increased from 80,000 t in 1996 to over 114,000 t in 1997. This increase in total catch was reflected throughout all the main fishing divisions in Sub area VII.

The catches taken in Divisions VIIIc and IXa have slowly increased in recent years and the 1997 catch of over 40,700 t continued this trend and is the highest recorded since 1977. The amounts of catch misreported during 1997 was about 72,000 t compared with 52,000 t in the previous year. These catches were mainly taken in Division IVa but were reported as having been taken in Division VIa. Catches from the fishery in the southern part of Division VIa which had developed considerably in recent years decreased in 1997 and fell from 20,000 t in the mid nineties to 15,000 t in 1997.

The catches per quarter and per Sub-area and by Division are shown in Table 2.2.2.1 and also in Figures 2.7.1.1 to 2.7.1.4.

The quarterly distribution of the fisheries in 1997 was very similar to that of 1995 and 1996. Over 34% of the total catch was taken during the 1st quarter as the shoals migrate through Sub-area VI to the main spawning areas in Sub-area VII.

Only 11% of the total catch was taken in Quarter 2, most of it from Sub-areas VI and VII. During Quarter 3 the main catches (33%)were recorded from Division IIa and Division IVa from the shoals on the summer feeding areas. During Quarter 4 the main catches (22%) were recorded from the overwintering areas in Divisions IVa and IVa. The main catches from Division VIIIc (88%) of the total for the division were taken in Quarter 1 and 2. Catches from Division IXa were evenly distributed throughout the year.

The quarterly distributions of the catches since 1990 are shown in the table below There appears to have been an important but gradual changes in the timing of the fisheries.

Percentage distribution of the total catches from 1990–1997

Year	Q1	Q2	Q3	Q4
1990	28	6	26	40
1991	38	5	25	32
1992	34	5	24	37
1993	29	7	25	39
1994	32	6	28	34
1995	37	8	27	28
1996	37	8	32	23
1997	34	11	33	22

National catches

The national catches recorded by the various countries for the different areas are shown in Table 2.2.2.2–2.2.2.5. As has been stated in previous reports these figures should not be used to study trends in national figures both because of the degree of misreporting, and because of the high "unallocated" catches recorded in some years due to some countries exceeding their quota. The main mackerel catching countries in recent years continue to be Norway, United Kingdom, Ireland, Netherlands and Russia.

The total catch recorded from Divisions IIa and Vb (Table 2.2.2.2) was believed to be about 105,500 t, which was very similar to that for 1996 (104,000 t). Most of this catch was taken by Norway and Russia. The total catch believed to have been taken from "international waters" in this area for 1997 was about 55,000 t. High levels of misreporting were recorded in 1994 (109,600 t) between Divisions IVa and Division IIa. However, there appears to have been little misreporting in recent yeas from these areas although there is no data to support this assumption.

The total catch recorded from the North Sea (Sub-area IV and Division IIIa) (Table 2.2.2.3) was 227,600 t compared with 212,800 t in 1996. About 73,500 t were believed to have been taken in Division IVa but were reported as having been taken in Division VIa. The main catches were recorded by Norway (96,300 t), while substantial catches, totalling were also recorded by Denmark (22,000 t) and the United Kingdom (19,000 t).

The total catch estimated from the Western areas (Table 2.2.2.4) was 195,820 t, after corrections for unallocated and misreported catches (minus 69,000 t). The unallocated, misreported catches and discards are mainly made up of an unallocated catch of approximately 4,600 t together with catches of about 73,500 t believed to have been taken in Division IVa. The national catches have been very stable for a number of years - the main catches being recorded by the United Kingdom (129,000 t), Ireland (53,000 t) and the Netherlands (28,000 t).

The total catch recorded from Divisions VIIIc and IXa (Table 2.2.2.5) was 40,700 t which is the highest total recorded since before 1977 and continues the increasing trend in catches from this area observed in recent years. The TAC for 1997 was 30,000 t while that for 1998 was 35,000 t.. The increased catches were as a result of increased prices for mackerel and the increased effort by the Spanish fleet on mackerel in Division VIIc (east) caused by the collapse in the anchovy fishery. Most of the catch from this area is taken by Spain (>90%).

2.2.3 Estimates of discards

At present only one country - the Netherlands - is providing information on discards but this information is not applied to any other fleets.

Information on discarding by the Dutch fleet is obtained from part (15–20%) of the pelagic fleet which is regarded to be representative for all areas and months where the pelagic fleet is operating (see also Section 1.7 on fleet description). Estimates on discards are not made by independent observers of the fishery activities, but the crew collects information

during each trip per haul concerning date, position, trawl duration, catch composition by species. This estimation of the catch of each haul is done at the time the catch is taken on board (before any discarding takes place). If a catch is lost by torn nets, it is also reported. The information on species composition of the catch is added later. Finally the information on discards is obtained by comparing catch and actual reported landings. This discard information by species is then applied only to the whole Dutch pelagic fleet by month and by ICES Division, but not to the international fleet. This report contains a number of tables in which catches and discards are reported on an annual basis, but not on a quarterly basis (however, the basic discard data are available by month and by ICES Division).

General information on discards in the pelagic fleets is provided in Section 1.4.3.

2.3 Stock Units

The results of two new studies were made available to the Working Group. One concerned the results of an EU funded tagging programme for juvenile and adult mackerel (WD Uriarte *et al.* 1998). The other concerned the results of a genetic study into the different stock components in the NEA mackerel (WD Nesbø 1998). In summary, Uriarte *et al.* concluded that the western and southern components were not functionally separate as fish tagged in the southern area could be recaptured in the western area. Nesbø concluded that the southern stock was older, more genetically diverse and separate to the western stock. This conflict needs to be resolved. Confirmation of the genetic studies should be considered with further and more standardised sampling, probably associated to a triennial egg survey. The Nesbø study was based on examples from the centres of the areas, and so could not describe where the genetic groups stopped and the next started. The Uriarte *et al.* study showed that fish from the southern area could migrate to the Norwegian Sea and back. One possible synthesis is that the components, if they exist, might be genetically different but that their behaviour is largely identical. For the southern and western components to exist there must be some homing behaviour and by now it is known that they follow the same migration path, and are mostly caught in the same fisheries. Furthermore, if the two components exist, neither the genetic nor the tagging studies allow any definition of boundaries between these components.

The Working Group agreed that work on tagging and genetics should continue as the exact definition of the status of these stock components remains an important subject.

2.3.1 Tagging information

Between the early 70s and 1995 several tagging experiments on mackerel (Eaton 1980, Hamre 1980, Rankine and Walsh 1982, Bakken and Westgard 1986, Iversen and Skagen 1989, Uriarte and Lucio 1996, in press) have demonstrated that mackerel from all spawning areas (North Sea, western and southern areas) migrate to the North of Europe up to Divisions IIa and IVa where they mix for the second half of the year. Uriarte and Lucio (op.cit.) (SEFOS project, AIR92-CT1905) demonstrated that the adult mackerel visiting the southern area are adults coming from the western area which continue their spawning migration through Division VIIIc before going back to the North (see Section 13.3.3 for further information and figure 13.3.3.1).

Recently, in 1997, a new international study project on the migration of both adult and young mackerel has been carried out by Portugal (IPIMAR), Spain (IEO and AZTI), Ireland (MI) and Norway (IMR) (Uriarte *at al.* WD 1998). This project entitled: "*Spatial Pattern of migration and recruitment of North east Atlantic mackerel*" (EU Study project contract 96-035) has the objectives of clarifying the migration pattern of adult mackerel from the southern and western areas and of determining the spatial pattern of juvenile recruitment from two nursery areas: the Northwest of Ireland and West of the Iberian Peninsula. A total of 119,913 mackerel were tagged along the European Atlantic coasts: 83,514 adults at the spawning time in western and southern areas and 36,399 of juveniles at different times of the year (Figure 13.3.2.2). The preliminary results of this study up to December 1997 concerning adults and juveniles are presented in Figure 13.3.2.3 and 13.3.2.4 respectively.

The preliminary conclusions derived from these Project 96/035 results are:

a) Adult mackerel from all the southern area (Division VIIIc) appear to join the general Migration of mackerel to the North of Europe during the second half of the year with the rest of the Northeast Atlantic population. This finding confirms the conclusions of the previous tagging experiment performed in 1994 in the Southern area, at the east of Sub-division VIIIc east (Uriarte and Lucio, op.cit).

b) Adult mackerel spawning in the western area moved at the end of summer and early autumn into the Norwegian Sea and northern part of the North Sea. This finding is congruent with the observations made for years by the IMR of strong entry of western mackerel into these areas in late summer (Iversen and Skagen 1989).

c) In contrast, young mackerel (both from the west of the Iberian peninsula and from the northwest of Ireland) seem to remain all close to the places where they were tagged.

From the tagging experiments performed on the spawners of the southern area in 1994 and 1997 several recoveries have been produced during spring time in the western spawning grounds. Most of the recoveries come, however, from the Northern areas reflecting probably the larger fishing effort recorded in those areas compared to the southern ones. It seems that adults from the southern and western areas have always been caught together.

Concerning the definitions of stocks, the tagging experiments suggest that there is mixing between southern and western components. No clear evidence of the homing behaviour can be obtained from the results obtained up to now. The conception of southern and western components is not inferred from the tagging data.

2.3.2 Genetic studies

One new piece of work on genetic differentiation of mackerel stocks was presented at this meeting (WD 1998 Nesbø). This WD was based on work on mitochondrial DNA, specifically, the cytochrome b gene and on the D-loop region. The preliminary conclusion was that four genetically different spawning populations can be defined; western, southern, North Sea and Mediterranean. It is suggested that this differentiation occurred after the last glaciation period, some 10,000 years ago. One implication from this is that as the North Sea stock is genetically different, the stock is likely to have to recover from collapse without recruitment from the western stock. A second implication is that it should be possible to study the mackerel found in the North Sea, both juvenile and adult to determine the current spatial distribution and the split between genuine North Sea stock and transients from the western stock. Perhaps most importantly, the impact of fishing on adult mackerel in IVa could be more precisely targeted to reduce the impact on the North Sea stock.

This work is very promising and should be encouraged.

2.3.3 Allocation of catches to stock

Since 1987 all catches taken in the North Sea and Division IIIa have been assumed to belong to the Western stock. This assumption also applies to all the catches taken in the international waters. It has not been possible to calculate the total catch taken from the North Sea stock component separately but it has been assumed to be 10,000 t for a number of years. This is because of the very low stock size and because of the low catches taken from Divisions IVb,c. This figure was originally based on a comparison of the age compositions of the spawning stock calculated at the time of the North Sea egg surveys This assumption has been continued in 1997 but it should be pointed out that if the North Sea stock should increase, then the figure may need to be reviewed. An international egg survey carried out in the North Sea during June 1996 provided a very low index of stock size in the area. A further egg survey in the North Sea is planned for 1999 and should give additional information on the state of the stock.

Prior to 1995 catches from Divisions VIIIc and IXa were all considered to belong to the southern mackerel stock, although no assessment had been carried out on the stock. In 1995 a combined assessment was carried out in which all catches from all areas were combined, i.e. the catches from the southern stock were combined with those from the western stock. The same procedure was carried out by the 1997 Working Group and again by the present Working Group - the new population unit again being called the North-east Atlantic mackerel unit.

The TAC for the Southern area applies to Divisions VIIIc and IXa. Since 1990, 3,000 t of this TAC, which has been fixed at 30,000 t, has been permitted to be taken from Division VIIIb in Spanish waters. This area is included in the "Western" management area. These catches (3,000 t) have always been included by the Working Group in the western component and are therefore included in the assessment for the Western area.

2.4 Biological Data

2.4.1 Catch in numbers at age

The 1997 catches in numbers at age by quarter for NE Atlantic mackerel (Areas II, III, IV, V, VI, VII, VIII and IX) are shown in Table 2.4.1.1. The percentage catch by numbers at age is given in Table 2.4.1.2.

The age structure of the catches of NE Atlantic mackerel is predominantly 1–6 year old fish. These age groups constitute 82% of the total catches. The 1993 year class (4 year old fish) dominated the catches throughout half of the areas where mackerel was caught. Fish belonging to the 1996 year class were dominant in the catches in Q3 Division VIa. In other areas the catches were dominated by young fish; in IVb, IVc and VIIh catches were dominated by 1 year old fish; in

VIId, and VIIe,f catches were dominated by 2 year olds; and VIIg catches were dominated by and 2 and 3 year old fish. Catches from Divisions IXa were again dominated by 0 and 1 group fish in 1997. This continues the trend of greater relative abundance of these age groups in the catch since 1995 (24%, 44% and 80% respectively). In VIIIc east the catches were predominantly age group 4–5 fish, while in VIIIc west 50% of the catch were age group 2 fish.

Age distributions of catches were provided by Denmark, England, Ireland, Netherlands, Norway, Portugal, Russia, Scotland and Spain. There are still major gaps in the overall sampling for age from countries which take substantial catches, notably Faroes, France, Germany and Sweden (combined catch of 52,156 t). In addition there were no aged samples to cover the entire catch from VIIa, VIIg, VIIk and Va (total catch 528 t). As in 1997, catches for which there were no sampling data were converted into numbers at age using data from the most appropriate fleets. This is obviously undesirable where the only aged samples available are from a different type of gear. The description of the allocation of age structures to unsampled catches is described in Molloy and Kelly (WD 1998).

Sampling data are further discussed in Section 1.4.1.

2.4.2 Length composition by fleet and country

Length distributions of some of the 1997 catches by some of the fleets were provided by England, Ireland, Netherlands, Norway, Portugal, Scotland, Spain and Russia. The length distributions were available from most of the fishing fleets and account for about 90% of the official catches. These distributions are only intended to give a very rough indication of the size of mackerel by the various fleets and do not reflect the seasonal variations, which occur in many of the landings. More detailed information on a quarterly basis is available for some fleets on the Working Group files. The length distributions by country and fleet for 1997 are shown in Table 2.4.2.1.

2.4.3 Mean lengths at age and mean weights at age

Mean lengths

The mean lengths at age per quarter for 1997 for the NE Atlantic are shown in Table 2.4.3.1. These data continue the long time series and may be useful in investigating changes in relation to stock size.

Mean weights

The mean weights at age in the catch per quarter and ICES Division for NE Atlantic mackerel in 1997 are shown in Table 2.4.3.2. Mean weights at age in the stock at spawning time for NE Atlantic mackerel are based on a weighted mean of the stock weights for the Western, Southern and North Sea stock components, with the exception of age group 1, which is based on a constant value used since 1988. The stock weights for NE Atlantic mackerel and the Western, Southern and North sea components are given in Table 2.4.3.3.

2.4.4 Maturity ogive

The maturity ogives for the North East Atlantic mackerel were obtained as averages weighted by the relative proportion of the egg production spawning stock biomass within the respective areas. Thus, for combining the western, southern and North Sea stock data, weighting factors of 0.825, 0.125 and 0.025 respectively were applied. The maturity ogives for the three different stocks and for the North East Atlantic mackerel are given in Table 2.4.4.1.

Maturity at age is constant for each year of assessment. However, it is important for assessment purposes that the maturity ogive represents the proportions of fish by age group that actually spawn, because the assessment is tuned to the SSB obtained from egg surveys. Therefore an estimation of the maturity ogive in 1998 will be obtained as part of the egg survey of the western and southern area (ICES 1997/H:4). In this context samples have been taken over areas of predominantly juvenile distribution as well as on the spawning grounds (see also Section 3.2.1.3). Samples will be analysed by histological examination to provide a more accurate estimate of the numbers of fish which will actually spawn in that year. Results will become available at next year's Working Groups meeting.

2.4.5 Natural mortality and the proportions of F and M before spawning

The value for natural mortality used by the Working Group for all components of the NE Atlantic mackerel stock is 0.15. This estimate agrees with the value obtained from Norwegian tagging studies carried out in the North Sea (Hamre 1978). The proportion of F and M before spawning for NE Atlantic mackerel is taken as 0.4 while for the Western Stock value is 0.4.

2.5 Fishery Independent Information

2.5.1 Long-term tagging studies to estimate mortality

No new information was presented at the Working Group meeting this year. Given the small amount of fishery-independent information the Working Group considers that these studies are valuable and should be continued.

2.5.2 Egg surveys

The historic time series of stage 1 egg production and SSB estimates, for the western area from 1977 to 1995, was updated at the Working Group in 1997 (Table 2.2.1 in ICES (1998/Assess:6)). No further changes have been made to that data set.

At the planning meeting in Lisbon, for the 1998 mackerel and horse mackerel egg surveys of the western and southern areas, the Working Group agreed that preliminary results of the 1998 egg surveys would not be available in time for either the current Assessment Working Group or for the October meeting of ACFM. Although some egg survey results might be available by the end of September, work on the analysis of the samples for fecundity, atresia and maturity at age would not be completed until early in 1999. As a consequence only an incomplete set of egg survey results, from the western area only, is available from the 1998 egg survey (see Section 1.5). These data have not been subjected to a rigorous check and must therefore be regarded as not having undergone a complete analysis.

The following information, on egg distribution was available for the western area only.

In the first sampling period in the western area, period 3, egg production was high along the shelf edge from 53°N down to southern Biscay. The main concentrations of stage 1 eggs were found in the vicinity of the Great Sole and Little Sole Banks. The boundaries of the distribution were fairly well defined except at the northern edge, 53°15'N, where stage 1 eggs occurred in five of the six sampled rectangles.

The peak of spawning occurred in the next period, period 4, and was concentrated very tightly along the shelf edge from the Butt of Lewis (58°N) to southern Biscay. Egg production throughout that area was evenly spread with no clearly identifiable major concentration. The boundaries of the distribution were well defined south of the Porcupine Bank area. To the north of this area the western edge was less well defined although there were no very high counts along this edge.

Spawning declined in period 5, although the samples taken from central Biscay southwards have not yet been analysed. Stage 1 eggs were found all the way south from the Butt of Lewis. They were concentrated along the shelf edge south of Ireland and to the west, off the shelf edge, west of Ireland and northwards. As in the previous period the boundaries of the distribution were less well defined to the north of the Porcupine Bank. There were some high numbers of stage 1 eggs well off the shelf edge along the western boundary of the sampled area and also at one station at the northern edge of the survey area.

Spawning had declined further in the final sampling period, period 6, although again the samples taken from central Biscay southwards have not yet been analysed. Production was concentrated on the shelf south of Ireland and into the Celtic Sea whilst from north-west of Ireland and northwards the production was to the west of the shelf edge. The boundaries of the distribution were fairly well defined south of 55°N but to the north along the western and northern edges of the sampled area high egg counts were found. Stage 1 eggs were also found in five of the six sampled rectangles at 59°15'N, to the north of the standard sampling area.

The preliminary estimate of total stage 1 egg production in the western area, from the samples analysed to date, is approximately 15% lower than the production measured in 1995. Because some of the samples have not yet been analysed, this is likely to be an under-estimate of total production.

No data on mackerel egg production in the southern area were available at the Working Group.

2.5.3 Winter acoustic surveys for mackerel

The surveys

In recent years a series of echosounder and sonar surveys have been carried out to study the mackerel during this period. Two of these were carried out by IMR Bergen and two by MLA. A working paper on one of the IMR surveys was presented to the Working Group in 1997 (Misund WD 1997) and on one of the MLA surveys in 1998 (Reid WD 1998). All four surveys were successful in locating and surveying the stock concentration, although in all cases it was

concluded that the surveys had probably not covered the whole stock. It should be emphasised that these surveys were designed for research purposes and not for abundance estimation. A partial stock estimate of 1.6 million tonnes was calculated for the MLA survey in 1995, and preliminary analyses suggest a similar biomass for the IMR 1996 survey.

Problems

There are a few problems to be expected in conducting acoustic surveys on this stock at this time. Most importantly, mackerel has no swim bladder, and so has a relatively low target strength (TS). The presence of other fish with swim bladders (e.g. herring) in any numbers will complicate the analysis as these will tend to dominate the acoustic return. Further the precise TS is poorly established, and so absolute abundance estimation will be difficult. Another problem is the weather in this area at this time of year which is often severe. It would also be useful if the global distribution of mackerel beyond the specified area could be documented for this time of year.

Advantages

Assuming that the problems described above can be overcome, there are a number of major advantages to this type of survey. These surveys can be carried out in a relatively short time (the MLA surveys lasted two weeks) and at a time of year when research vessels are under less intense pressure. They can thus be carried out on an annual basis. Acoustic surveys include trawling. As a result the stock estimate would also be available in age disaggregated form. Acoustic surveys would be best carried out in the years between the egg surveys.

2.5.4 Trawl surveys for juvenile mackerel (mackerel recruit indices)

Once again the traditional mackerel recruit index for mackerel has not been calculated. This is due to consistent doubts about the performance of the index which has shown an upward trend in recent years in relation to the recruitment calculated from the assessment (ICES 1998/Assess:6). A new analysis approach has been developed using Generalised Additive Modelling (GAM) described in Section 2.8. which show considerable promise. The recruit distributions are presented in Section 2.7.2.

As noted in last year's report (ICES 1998/Assess:6) it continues to be important that these surveys be continued. Poor coverage in 1997/98 has made it difficult to follow trends and may also be detrimental to the utility of the GAM based analysis. The results from these surveys are the only available source of data on juvenile distributions, and this forms a significant part of the advice requested from this Working Group to NEAFC (see Section 13).

2.6 Effort and Catch per Unit Effort

Commercial CPUE

The catch-per-unit- effort is only provided for the southern area.

Table 2.6.1.1 and Figure 2.6.1.1 show the fishing effort data from Spanish and Portuguese commercial fleets. The table includes Spanish effort of the hand-line fleets from Santona and Santander (Sub-division VIIIc East) from 1989 to 1997 and from 1990 to 1997 respectively, for which mackerel is the target species from March to May. Table 2.6.1.1 and Figure 2.6.1.1 also show the effort of the Aviles and La Coruña trawl fleets (Sub-division VIIIc East and VIIIc West) from 1983 to 1997 and the Vigo purse-seine fleet (Sub-division IXa North) from 1983 to 1992 for which mackerel is a by-catch. The Spanish trawl fleet effort corresponds to the total annual effort of the fleet for which demersal species is the main target. Portuguese mackerel effort from the trawl fleet (Sub-division IXa Central-North, Central-South and South) during 1988–1997 is also included and as in Spain mackerel is a by-catch.

Table 2.6.1.2 and Figure 2.6.1.2 show CPUE corresponding to the fleets referred to in Table 3.3.3.1. The Spanish trawl fleets in 1997 showed an increase compared with the ones from 1996, as well as the hand-line fleets. The Portuguese trawl fleet CPUE decreased from 1996 to 1997.

Catch-per-unit-effort, expressed as the numbers fish at each age group, for the various fleets is shown in Table 2.6.1.3.

2.7 Distribution of Mackerel

2.7.1 Distribution of commercial catches for mackerel

The distribution of the mackerel catches taken in 1997 is shown by quarter and rectangle in Figures 2.7.1.1–4. These data are based on catches reported by Portugal, Spain, Netherlands, Germany, Denmark, Norway, Sweden, Russia, Faroes, UK and Ireland. In these data the Spanish and Portuguese catches are not based on official data.

First Quarter 1997

Catches during this quarter totalled about 187,000 t. There was again evidence of misreporting between Divisions IVa and VIa, with large catches west of 4°W. Again the split between these two areas should be treated with caution. The general distribution of catches was similar to 1996 and 1995 suggesting that the pattern and timing of the pre-spawning migration remains constant. Slightly more catches were apparently taken in the English channel area in 1997 than 1996. The catch distribution is shown in Figure 2.7.1.1.

Second Quarter 1997

Catches during this quarter totalled about 61,700 t, up on 1996. The general distribution of catches was similar to 1996. The main catches being taken east of Faroe, SW of Ireland and around the Iberian peninsula. The catch distribution is shown in Figure 2.7.1.2.

Third Quarter 1997

Catches during this quarter totalled about 162,300 t. The general distribution of catches was similar to 1996 and 1995. The main catch areas were in the area west of Norway and in Faroese and international waters in the Norwegian Sea. The catch distribution is shown in Figure 2.7.1.3.

Fourth Quarter 1997

Catches during this quarter totalled about 111,100 t. The general distribution of catches was similar to 1996. The main catches were taken in the area west of Norway across to Shetland. Smaller catches were taken west of Scotland and Ireland and in the English Channel. There were some indications of more catches in the Cantabrian Sea. The catch distribution is shown in Figure 2.7.1.4.

2.7.2 Distribution of juvenile mackerel

Surveys in winter 1997/98

Fourth Quarter 1997

No data were available at this time for the North Sea or the Western Approaches for quarter 4 1997. In those areas covered, relatively low abundances were recorded for both 0 and 1 year old fish (Figures 2.7.2.1 and 2). West of Scotland and Ireland catch rates for age 0 were greatly reduced from 1996. The only area to maintain similar abundances to 1997 was off the north Portuguese coast.

First Quarter 1998

As in the previous quarter catch rates were much lower than in 1997. Good catches of 1 year old fish were taken in the central North Sea, which was not seen in 1997. However, there was no evidence of the large numbers of the 1996 year class seen in the northern North Sea in this quarter in 1997. There were also good catches of 1 and 2 year old fish in the Cornwall area (Figures 2.7.2.3 and 4).

Trends in survey results

Reduced survey effort makes it difficult to assess whether the trends in recruit survey data reported previously (ICES 1998/Assess:6) have been maintained. In quarter 4 there continues to be a "hot spot" near the Spanish-Portuguese border and catch rates west of Ireland and the Hebrides remain low. In quarter 1 there continue to be reasonable catches of age 1 fish in the North Sea, although not on the scale of 1997. Based on recent trends (ICES 1998/Assess:6), the low catch rates off Ireland and the Hebrides compared to the reasonable catches off Cornwall would suggest that 1997 will not prove to be a good recruitment year.

2.7.3 Distribution of spawning fish

There were strong indications from the 1998 mackerel egg surveys that the recent trend of a northwards extension of the spawning area was continuing. High densities of recently spawned eggs were found on the northernmost edge of the survey area, at 58°15'N, in June and spawning in that area continued into July.

The distribution of spawning at the start of the season, in March, continues to follow the historical pattern of a strong association with the shelf edge, with the highest concentrations in the vicinity of the Little Sole and Great Sole Banks.

By the end of April and in early May this pattern was still evident from southern Biscay to south-west of Ireland. To the north of this area there was extensive spawning over the Porcupine Bank and extending west off the shelf edge to the west of Scotland.

During June most of the spawning was from south-west of Ireland northwards with the major concentrations again over the Porcupine Bank and off the shelf edge west of Scotland, up to 58°15'N.

At the end of the spawning period, in July, the northwards extension of the spawning area was still evident, with some spawning activity as far north as 59°15'N. To the south of Ireland the spawning followed the typical pattern, spreading east from the shelf edge over the Celtic Sea. By July spawning was over in the whole of Biscay and along the Cantabrian coast.

The only data available at the Working Group on mackerel spawning in the southern area in 1998 were from surveys off the Cantabrian and Galician coasts in March and late April. Spawning in both periods was typically strongly associated with the narrow shelf with very little spawning beyond the 500 m depth contour.

2.7.4 Winter distributions from acoustic surveys

Recent acoustic surveys in the north-eastern part of the North Sea by Scotland and Norway in 1996 and 1997 have confirmed that the bulk of the western mackerel stay in this area from October to at least the end of December. Scottish and Netherlands surveys in January 1994 and 1995 indicate that the migration to the spawning areas then commenced in January. Recent reports from commercial vessels confirm that this pattern appears to have continued into 1998.

2.8 Recruitment Forecasting

In previous Working Groups doubt has been expressed about the value of the combined mackerel recruit index derived from the series of bottom trawl surveys in quarters 1 and 4 of each year (ICES 1996/Assess:7; ICES 1995/Assess:2). Evidence was presented (ICES 1997/Assess:3) that this might be explained by the more northerly distribution of the juvenile fish in recent years and it was recommended that further modelling studies be carried out to explore this possibility.

At the Working Group a comparison was made between the recruitment indices derived from the available survey series and the ICA estimates of recent recruitment at age 0. Last year it was suggested that the fit between the assessment series and the Scottish west coast quarter 1 survey had broken down in 1997 (Figure 2.8.1.b); the survey index giving a very low estimate for the 1996 year class. The juvenile distribution maps (ICES 1998/Assess:6) showed a dramatic increase in age 1 fish in the northern North Sea and based on the assumption that these fish might belong to the Western "stock" rather than the North Sea "stock" they were then included in the west coast index, resulting in an improved fit to the VPA estimates from the catch at age data. Subsequent surveys from the Western area (Figure 2.8.1.c,d,e) have also indicated that the strength of the 1996 year class is below the average of recent years, but stronger than the weak year classes of 1972, 1977, 1982 and 1983. The indices are consistent at age 0 and age 1. The A Coruña CPUE index for age 1 (Figure 2.8.1.f), which was used as an qualitative index in last year's assessment, also indicates a 1996 class equivalent to the mean of recent years. These indices are in contradiction to those recorded in the Southern area by the Portugal and Spanish October surveys, (Figure 2.8.1.g and h, Table 3.3.2.2.1). Both indicate that there has been an increased catch of the 1996 year class, although historically they have not followed the ICA time series.

The survey indices show that the strength of the 1997 year class is close to the average of recent years.

The results of analyses carried out at this years meeting have established that there is a latitudinal drift in the centre of gravity of the catches of juvenile mackerel which is correlated with changes in water temperature. Higher temperatures being associated with a northward movement of the distribution of catches of the combined and individual survey components. The calculations assume that the geographic bounds of the areas covered by the surveys are relatively constant throughout the time series.

In order to establish whether this response could be used in a model for predicting year class abundance from trawl survey data, a two stage Generalised Additive Model (GAM, Hastie, T. and Tibshirani, R. 1990.) was fitted to the catch data for age group 0. The model incorporated a lowess smoothed latitude-longitude surface for the position at which the catches are taken, a lowess smoothed annual temperature effect and separate responses for each of the surveys. In Stage 1 the model is fitted to binomial data, indicating whether a catch was recorded at a station, using a log link function

(McCullagh, P. and Nelder, J. A. 1983). In Stage 2 the stations at which catches were taken were modelled with a Gamma error structure again with a log link.

The model results are presented graphically in Figures 2.8.2 and 2.8.3. In both figures the upper left graph presents the year class effect, the upper right the survey effect, the lower left the latitude longitude surface and the lower right the smoothed temperature effect. The trawl survey labels ("count") are: 1 – the English March survey, 2 – the French September/October survey, 3 – the Ireland October/November survey, 4 – the Netherlands November/December survey, 5 – the Scottish March survey, 6 – the Scottish November/December survey. The GAM estimated upper and lower twice-standard-error curves are plotted as hashed lines for the year class, country and temperature effects.

The distance between the standard error lines indicates that the year class effects fitted by both models are poorly determined for the 1984, 1985 and 1986 cohorts and should not be used in any index series. Excluding those years, the year class effects for the probability of recording a catch are relatively constant throughout the time series, apart from the final year, for which only the English and Scottish 1st quarter surveys are currently available. These surveys have a higher probability of recording positive catches as is shown by the country effects (labelled 'count') in Figure 2.8.2.b. Encouragingly, the GAM latitude longitude surfaces for the two models reflect the known distribution of the age 0 fish, which are distributed in the areas of the Celtic Sea, West of Ireland and West of Scotland. As was established in the preliminary studies the catches and the probability of making a catch exhibit a positive correlation with sea temperature.

A combined survey index, calculated by multiplying together the exponents of the year class effects from the two stages, is presented in Figure 2.8.4 along with the separable populations estimated by ICA at age 0, for the same time period. The two series show fairly good agreement and give similar patterns for the 1996 and 1997 year classes to those seen in the individual survey results presented in Figure 2.8.1. The increasing trend noted in recent years for the indices derived from average catches appears to have been removed by the use of a sea temperature effect.

Further developments of the model are planned. These include the use of temperature data for each individual survey and the addition of an index based on the age 1 catches. As noted in previous reports (ICES 1997/Assess:3) there appears to be a tendency in recent years for high catch rates to be taken at the extreme north and south ends of the range in good recruit years. There may be two possible explanations for this. First, that following a good recruit year the juvenile fish tend to spread out over a wider area, the so called "basin effect". Or secondly, that the conditions which lead to a good recruitment also tend to result in a greater transport of the young fish into the Hebrides area. Extensions of the GAM model would provide a method for exploring these scenarios.

The conclusion from these studies is that trawl indices could perhaps be used for modelling the recruitment to the mackerel stock if the influences of environmental conditions on this highly migratory species are taken into consideration. However, the range of years over which the survey indices can be calculated does not include the extreme variation observed in the 1970s and early 1980s and the predictive power of the model is not tested at these levels. A requirement of the use of this form of model is the availability of temperature data for the months prior to, and at the time of the survey. The collection of bottom trawl recruit data continues to be important in order to retain an appreciation of changes in juvenile distribution and their potential impact the predictions.

2.9 State of the Stock

2.9.1 Data exploration and preliminary modelling

Trial runs with the ICA were made to explore in particular the sensitivity to two kinds of model assumptions, the number of years with separable constraint, and the relative weighting of the SSB estimates for the egg surveys, to the catches at age. The background for this is the problem that appears when the last catch-independent data point is far back in time. This provides little information as to the recent development of the stock, the estimate of which relies entirely on how catch estimates derived with the assumed fishing pattern fit the actual catches. This fit is quite sensitive to deviations from the assumed selection pattern.

The ICA estimates of the stock numbers in the years of separable constraint, is weakly influenced by information from previous years, when this is given as absolute measures of abundance. Reducing the number of years with separable constraint therefore also reduces the number of SSB data points that influence the calibration of the population matrix. Accordingly, as the number of years with separable constraint is reduced, the perception of the stock in recent years is increasingly dominated by the last data point. This is illustrated in Figure 2.9.1.1. In particular this is apparent when the number of years with separable constraint is reduced from 8 to 7, by which the influence of the 1992 SSB estimate is lost.

The final stock estimate is a compromise between the signal given by the survey data and that given by the catches. The influence of each of these components can be scaled by the relative weight given to the survey data. This is illustrated in Figure 2.9.1.2. One possible alternative would be to weight the data according to the inverse estimated variance of the residuals. However, this variance estimate will reflect inconsistencies in the data more than how much faith one should put in the surveys compared to the combination of the catches and the separable assumption.

In ICA, there is an implicit weighting of each category of information, according to the number of data points that contribute to the objective function. The inclusion of another year of catch data therefore implies a downweighting of the survey data, in particular if the number of years with separable constraint is small. Therefore, keeping all model choices similar from year to year does not imply that all model assumptions are similar. As shown in Figure 2.9.1.2, the stock estimate for the recent years is very sensitive to the weighting of the survey data.

Given these sensitivity problems, the Working Group decided not to present a new analytical assessment until the SSB estimate from the 1998 egg survey data is ready. To provide an intermediate guidance for management, a simple projection of the 1997 Working Group stock estimate was made (Section 2.9.2).

Provisional ICA assessments were made with preliminary data for the 1998 egg survey for both the NEA mackerel and the Western mackerel. The results are presented in Tables 2.9.1.1–10 and 2.9.1.11–20 respectively. The diagnostic graphs are in Figures 2.9.1.3–6 and 2.9.1.7–10, respectively. These results indicate a reduction of SSB in recent years by about 10% compared to the assessment made last year. This number is still preliminary, and based on incomplete data, so this assessment should only be taken as a part of the exploratory runs, and as an indication of what to expect if the final result is similar to the preliminary one. The SSB estimates, together with the results of runs with similar model assumptions and the 1997 Working Group assessment are shown in Figures 2.9.1.11–12.

In both these runs, the estimated SSB in 1998 is very close to the SSB indicated by the egg survey. For previous years, the ICA estimate is generally below the egg estimates. This illustrates some of the conflict between the indications by the catches at age and the egg survey data. The further away the egg survey is, the more will the catches dominate the assessment for the last years, and these will tend to indicate a lower stock. This signal is weak, however, perhaps due to the poor contrasts in the catch at age matrix, so when there is a survey in the last year, the stock estimate will to a large extent be adapted to that value. The text table below, which shows the effect of upweighting and downweighting the survey information with and without the last survey data point, on the SSB-estimate in 1997, again illustrates this sensitivity problem.

	Survey weight = 0.1	Survey weight = 1	Survey weight = 10
1998 egg est. included	1235	2200	2390
1998 egg est. excluded	621	2200	2920

SSB estimate in 1997 in thousand tonnes.

2.9.2 Stock assessment

No new assessment was carried for reasons given in Section 2.9.1. The assessment on the North East Atlantic mackerel as carried out at last year's Working Group meeting was therefore used for assessment purposes. In order to be able to carry out catch predictions (Section 2.10) the starting numbers at age in the population on the first of January 1998 were projected from the numbers at age on first of January 1997 by using the catch numbers at age of 1997. The separable fishery pattern for 1996 from last year's ICA was then tuned to such a level that the SOPs corresponded to the catch of 1997 (570,000 t) as shown in the text table below. The calculated F(4–8) from these rescaled fishing mortalities is estimated at 0.22.

Age	N pop. 1/1/97	catch 1997	F calc.	N 1/1/98	F = F-pattern of 1996
0	3872	36.01	0.010	-	0.0063
1	3312	144.39	0.048	3299.3	0.0306
2	3701	186.48	0.056	2716.7	0.0854
3	1696	238.43	0.163	3012.5	0.1454
4	2069	378.88	0.218	1238.6	0.1908
5	1131	246.78	0.265	1429.3	0.2160
6	652	135.06	0.250	744.5	0.2108
7	383	84.38	0.268	435.9	0.2340
8	436	66.5	0.178	251.4	0.2466
9	222	39.45	0.211	313.6	0.2961
10	223	26.73	0.138	154.5	0.2751
11	86	13.95	0.191	167.1	0.2593
12+	161	24.97	0.182	228.2	0.2593
	SSB=2530 kt	catch 570 kt		SSB = 2660 kt	F(4-8) = 0.2196

2.9.3 Reliability of the assessment and uncertainty information

In addition to the modelling problems that have been described in Section 2.9.1, some other sources of uncertainty should be pointed out.

The assessment relies heavily on the catch data, and in particular the age structure of the catches. In this respect, it is problematic that a fairly large proportion of the total catch volume has to be distributed by age based on a small number of samples from the fisheries in question, as discussed in Section 1.4.1. Moreover, there is sparse information about underreporting, slipping and discards. Since the stock abundance estimate is calibrated using absolute SSB-values for recent years, and with a VPA for previous years, underestimation of the catches will tend to lead to overestimation of the stock in recent years and underestimation in earlier years. In this respect, one should note that the estimate of the SSB is below the egg survey estimates in most previous years. The finding that it almost hits the egg estimate for 1998 may be due to this. This result is highly sensitive to the relative weighting of the survey data, however.

The more general problem is that of doing an assessment with very sparse supplementary data. In a previous Working Group (ICES 1997/Assess:3), simpler models using SSB estimates from egg surveys and mortality estimates from tagging data were explored. Although such models leave out much of the detailed information in the age-disaggregated data, they may be more robust with respect to overall trends in the state of the stock. These trends are not very different from those of the ICA assessment. Thus, despite the difficulties encountered in the present attempt to assess the stock, the Working Group considers it unlikely that the perception of the present state of the stock, and of the trend in recent years is likely to be grossly misleading.

The provisional runs using the preliminary SSB estimate from the 1998 egg survey, gave an estimate of the SSB in 1998 slightly below the projected value starting with the 1997 assessment (see Section 2.9.1), and very close to the actual survey estimate of SSB. As pointed out in Section 2.9.1, this result is strongly dependent on the relative weighting of the survey data, however.

A more formal uncertainty estimation will be attempted when a new egg survey estimate is finalised.

2.10 Catch Predictions

Table 2.10.1 presents the input values for the catch forecasts.

The starting numbers at age in the population on the first of January 1998 are a projection from the numbers at age on first of January 1997 by using the catch numbers at age of 1997, because no new assessment was carried out at this meeting (see Section 2.9).

Recruitment of the 1998 year class = 3872 million, which corresponds to the geometric mean (1972–1995) of the recruitment to the Western mackerel, raised by the average ratio (1.09) of the estimated Western and Southern area recruitments for the period 1984–1994 (the same as used for last year's prediction). Recruitment of the 1996 and 1997 year classes are assumed to be average.

Catch forecasts have been calculated for the provision of area based TACs. Two "fleets" have been defined, corresponding to the exploitation of the western area, including the North Sea and the unregulated catches taken in international waters, Division IIa (Northern), and the southern area (Southern).

The exploitation pattern used in the prediction was the separable ICA Fs for the final year taken from last year's assessment for the reasons given in Section 2.9. These were subdivided into partial Fs for each fleet using the average ratio of the fleet catch at each age and the total catch at each age for the years 1995–1997. Weight at age in the catch was taken as an average of the values for the period 1995–1997 for each area. Weight at age in the stock was calculated from an average (1995–1997) of weights at age for the NEA mackerel stock.

The total of agreed 1998 TACs over all by TAC regulated areas, increased by 80,000 t compared to 1997 (see Section 2.1). The catch for 1998 is assumed to be 650,000 t corresponding to the 1997 catch of 570,000 t plus this TAC increase of 80,000 t.

Eight single option summary tables are presented and summarised in the text tables below. Tables 2.10.2.a–d refer *status quo* fishing mortality in 1998 and Tables 2.10.3.a–d to a constant catch option for 1998 of 650kt. Each of these two options for 1998 are then followed by:

F1999 = F2000 = 0.15 as agreed between the EU and Norway for 1999;
F1999 = F2000 = 0.175 corresponding to F0.1;
F1999 = F2000 = 0.20 corresponding to the mean F in the 80's when SSB remained stable;
F1999 = F2000 = 0.2325 corresponding to the mean fishing mortality for the period 1995–1997.

UNITS: '000 t

	Status quo (F97=F98=0.22) F=0.15 1999,2000			*Status quo* (F97=F98=0.22) F=0.175 1999,2000			*Status quo* (F97=F98=0.22) F=0.20 1999,2000			*Status quo* (F97=F98=0.22) F95-97=0.233 1999,2000		
Year	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB
1998	0.22	621	2660	0.22	621	2660	0.22	621	2660	0.22	621	2660
1999	0.15	437	2734	0.175	504	2710	0.20	571	2687	0.233	654	2656
2000	0.15	462	2866	0.175	523	2788	0.20	580	2712	0.233	648	2617

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	Catch 1998 = 650 kt F=0.15 1999,2000			Catch 1998 = 650 kt F=0.175 1999,2000			Catch 1998 = 650 kt F=0.20 1999,2000			Catch 1998 = 650 kt F95-97=0.233 1999,2000		
Year	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB
1998	0.23	650	2649	0.23	650	2649	0.23	650	2649	0.23	650	2649
1999	0.15	433	2771	0.175	500	2687	0.20	565	2663	0.233	648	2633
2000	0.15	458	2846	0.175	519	2768	0.20	575	2693	0.233	643	2599

Status quo F was only taken as the fishing mortality of 1997 and not as the a mean over the period 1995–1997, because the fishing mortality decreased considerably due to a strong decrease in the agreed TACs during this period. However, the option of a catch of 650 kt in 1998 and a F_{95-97} of 0.2325 in the following two years is approximately equal to a *status quo* F of 0.23 over the whole period of 1998 to 2000.

The forecasts predict that SSB will increase except when fishing mortality remains as high as the mean fishing mortality over the period 1995–1997 (F = 0.233).

Two management option tables are presented. Table 2.10.4 presents the option for *status quo* F in 1998, Table 2.10.5 presents a constant catch for each fleet in 1998; each is followed by a range of F98 values for both areas.

The forecasts for the two scenarios are in close agreement with the predicted SSB values, because no new assessment was carried out.

2.11 Short-Term Risk Analysis

ICES (1991/Assess:22) performed a sensitivity analysis for *status quo* forecasts made using data from this stock. The results revealed that the forecasts were sensitive to the estimates of the strength of the year class that recruited two years before the year of the assessment. The forecast made this year will be sensitive to the estimated fishing mortality in 1999.

Due to the decision of the Working Group to project the present stock numbers from 1997 to 1998 using the catch in 1997 (Section 2.9.1), last year's assessment was used as basis in the present short-term risk analysis. The sensitivity analysis need stock numbers, recruit estimates, F-values and other population parameters and their associated error estimates (CVs) to be run. Thus, the errors of the various population parameters of the 1997 ICA run were entered into the sensitivity analysis together with population numbers for 1998 from the projection of last years assessment (Section 2.10). In the forecast the geometric mean of the time series (1972–1995) was used. To obtain an estimate of the CV for the recruitment the CV of the GM estimate was used. See Table 2.11.1 for a complete list of input data to the sensitivity analysis.

The WGFRAN4 and SENPLOT software produces a plot of the various (input) population parameters in descending order of significance to the uncertainty of the short-term prediction. The estimation of the accuracy of the catches or the fishing mortality in 1999 (HF99 - effort multiplier, see Table 2.11.1) is the single most important factor to the sensitivity of the short-term prediction (Figure 2.11.1).

The short-term risk ogive plots that were produced from the sensitivity analysis were not reproduced in the report due to the following concerns: 1) the present population input data to the sensitivity analysis were projected an extra year of reasons mentioned above, 2) the estimates of the stochastic error terms representing the CVs of the population parameters were taken from last year's assessment, and 3) it was unclear to which extent the stochastic terms in this model covers the uncertainties in the present assessment (cf. Section 2.9.1).

2.12 Medium-Term Predictions

No new medium-term predictions were carried out because 1) last year's assessment was projected one year forward and 2) the actual catch taken in 1997 (570 kt) was very similar to the assumed catch of 1997 (560 kt) as used for the predictions at last year's Working Group meeting.

2.13 Long-Term Yield

Table 2.13.1 and Figure 2.13.1 present the yield per recruit forecasts for the both areas from 1997 Working Group report as no new assessment was done this year by the Working Group.

F_{max} is poorly defined at a combined reference F of about 0.5. However, for pelagic species F_{max} is generally estimated to be at levels of F well beyond sustainable levels and should not be used as a fishing mortality target. $F_{0.1}$ was estimated last year using the same selection pattern, the full age range and a 12 plus group, to be 0.175.

2.14 Reference Points for Management Purposes

The Working Group was asked to:

> *consider the reference points proposed by SGPAFM, adopting those reference points or presenting alternatives with reasons for the alternative selection.*

In last year's Working Group Report (ICES 1998/Assess:6) an extensive and detailed analysis on potential candidates for reference points for the precautionary approach were given. The reference points suggested by SGPAFM were largely based on this analysis and are in line with the suggestions from the Working Group. The present Working Group found no reason for alternative reference points and decided to adopt the reference points suggested by SGPAFM shown in the text table below.

A new set of software for calculating reference points (PA Software Users Guide, CEFAS, Lowestoft) were presented to the present Working Group, which calculates the various precautionary reference points of spawning stock biomass and fishing mortality. The Working Group used the PA software to produce graphs and tables of the proposed reference points (Figures 2.14.1–6 and Tables 2.14.1–2). The values of the reference points calculated are similar to the values used previously by Working Group. In particular F_{loss} (0.26) corresponds closely to the value of F_{lim} = 0.25 used by the SGPAFM.

WGMHSA '97 proposal
B_{low} = MBAL = B_{loss} = 2.3 million t, being a low biomass to be avoided.
B_{lim} = undefined
F_1 = 0.122, being F when SSB is less than B_{low}. Basis replacement line for 1 SD below geometric mean recruitment (see sec. 3.4.9 in ICES CM 1998/Assess:6).
$F_{pa} = F_{0.1}$ = 0.175
Used by ACFM '97
2.3 million t implicitly accepted as MBAL
F between 0.2 and 0.15 gives low probability of SSB < MBAL
SGPAFM proposal and adopted by present Working Group
B_{pa} = MBAL = B_{loss} = 2.3 million t.
B_{lim} = undefined
$F_{pa} = F_{0.1}$ = 0.175
F_{lim} = 0.25 to 0.3

The MBAL value of 2.3 million t, which corresponds to B_{loss}, has previously been regarded as a limit, below which strong measures were taken to bring the stock above this value. This is suggested as a B_{pa}. A B_{lim} cannot be defined in this case. A fishing mortality at $F_{0.1}$ = 0.175 has been suggested last year by the Working Group (ICES 1998/Assess:6) as a target, and can be taken as F_{pa}. The fishing mortality at which the risk of stock depletion starts to increase in long-term simulations is suggested as a candidate F_{lim} = 0.25–0.3 depending on the assumptions in the uncertainties in the models. This is based on an S-R relationship where R declines linearly to the origin below B_{loss}. Consequently the Working Group proposes no change to the reference points previously proposed.

2.15 Harvest Control Rules

The subjects of reference points and management measures were treated extensively by the two last years' Working Groups (ICES CM 1997/Assess:3, ICES CM 1998/Assess:6). Since there is little new background information this year, no new evaluations of this kind have been made.

The Working Group has over several years recommended to maintain SSB above 2.3 million tonnes. This value corresponds approximately to the historical minimum, and was adopted as an MBAL value for the biomass. Within the range of historical SSBs, there is no clear dependence of the recruitment on the SSB. Below this value, there is no basis for assumptions about the stock-recruitment relationship.

The previous studies concentrated on a harvesting regime based on a constant fishing mortality, which should be set sufficiently low to imply a low risk of reducing the stock below the historical minimum. The recruitment of this stock has moderate year-to-year variations, and a fairly large number of year classes are represented in the fishery. In this case, a fixed catch regime might be considered. This could give a gain in terms of more stable and predictable catches, but would require a lower fixed catch than the average expected by an optimal fixed F regime. It may also involve a greater risk of deteriorating the stock if the monitoring and management system is unable to react rapidly to unexpected changes in the state of the stock. A further alternative would be to set quotas for 2–3 years, which is more relevant with this stock than with many others since the catch-independent information only comes every third year. If such alternatives are to be considered, they should be properly explored by simulations, which has not been done up till now.

2.16 Management Measures and Considerations

The exploitation history of this stock in relation to the proposed precautionary reference points is shown in Figure 2.16.1. For the time being, the suggestion by the Working Group would be a fixed F regime with an F-value close to $F_{0.1}$ = 0.175 as also suggested by the Working Group in 1997 (ICES CM 1998/Assess:6), and shown in Figures 2.14.1–6. For 1998, ACFM recommended a fishing mortality in the range 0.15–0.20, while the actual F in 1997 was 0.22. The

Working Group once again has to emphasise that the fishing mortalities derived from studies of predictions and simulation apply to the total exploitation of the stock, including areas where no quota regulations apply. At present, the stock is assumed to be slightly above 2.3 million tonnes. If the fishing mortality can be kept at the suggested level, the stock is expected to increase to a satisfactory level without further measures. A fishing mortality at the 1996–1997 level will, according to the medium-term predictions done by the 1997 Working Group, maintain the SSB at present levels.

Some discrepancies exist between areas used for catches and TAC areas, e.g. in the Southern area and in international waters. As for the other stocks, the Working Group recommends that the areas used for catch forecasting and TAC should be brought into correspondence.

Table 2.2.1.1 Catches in tonnes of Scomber japonicus in Divisions VIIIb, VIIIc and IXa in the period 1982-1997.

Country	Sub-Divisions	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Spain	Division VIIIb										487	7	4	427	247	778	362
	VIIIc East	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903.2	2558	2633	4416
	VIIIc west															47	610
	Total	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903.2	2558	2679	5026
	IXa North												2557	7560	4705	5066	1727
	IXa South											895	800	1013	364	370	613
	Total											895	3357	8573	5068	5437	2340
	Total Spain	322	254	656	513	750	1150	1214	3091	1923	1989	1761	5253	10903	7872	8894	7729
Portugal	IXa Central-North	-	0	236	229	223	168	165	281	228	137	914	543	378	913	785	521
	IXa Central-South	-	244	3924	4777	3784	5299	838	2105	5792	6925	5264	5019	2474	1544	2224	2109
	IXa South	-	129	3899	4113	4177	3409	2813	4061	2547	3080	2803	1779	1578	1427	1749	2778
	Total Portugal	664	373	8059	9118	8184	8876	3816	6447	8568	10142	8981	7341	4430	3884	4759	5408
TOTAL	**Division VIIIb**										487	7	4	427	247	778	362
	VIIIc East	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558	2633	4416
	VIIIc west															47	610
	Division VIIIc	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558	2679	5026
	IXa North												2557	7560	4705	5066	1727
	IXa Central-North			236	229	223	168	165	281	228	137	914	543	378	913	785	521
	IXa Central-South		244	3924	4777	3784	5299	838	2105	5792	6925	5264	5019	2474	1544	2224	2109
	IXa South	664	129	3899	4113	4177	3409	2813	4061	2547	3080	3698	2579	2591	1790	2120	3391
	Division IXa	664	373	8059	9118	8184	8876	3816	6447	8568	10142	9876	10698	13003	8952	10195	7748
	Total	986	627	8715	9631	8934	10026	5030	9538	10491	12131	10742	12594	15333	11756	13653	13137

Table 2.2.2.1 Catches of MACKEREL by area. Discards not estimated prior to 1978. (Data submitted by Working Group members.)

Year	Sub-area VI			Sub-area VII and Divisions VIIIa,b,d,e			Sub-area IV and Division IIIa			Divs. IIa,Vb[1]	Divs. VIIIc, IXa	Total		
	Landings	Discards	Catch	Landings	Discards	Catch	Landings	Discards	Catch	Landings	Landings	Landings	Discards	Catch
1969	4,800		4,800	66,300		66,300	739,182		739,182			810,282		810,282
1970	3,900		3,900	100,300		100,300	322,451		322,451	163		426,814		426,814
1971	10,200		10,200	122,600		122,600	243,673		243,673	358		376,831		376,831
1972	10,000		10,000	157,800		157,800	188,599		188,599	88		356,487		356,487
1973	52,200		52,200	167,300		167,300	326,519		326,519	21,600		567,619		567,619
1974	64,100		64,100	234,100		234,100	298,391		298,391	6,800		603,391		603,391
1975	64,800		64,800	416,500		416,500	263,062		263,062	34,700		779,062		779,062
1976	67,800		67,800	439,400		439,400	303,842		303,842	10,500		821,542		821,542
1977	74,800		74,800	259,100		259,100	258,131		258,131	1,400	27,417	620,848		620,848
1978	151,700	15,100	166,900	355,500	35,500	391,000	148,817		148,817	4,200	26,508	686,725	50,700	737,425
1979	203,300	20,300	223,600	398,000	39,800	437,800	152,323	500	152,823	7,000	22,475	783,098	60,600	843,698
1980	218,700	6,000	224,700	386,100	15,600	401,700	87,391		87,391	8,300	15,964	716,455	21,600	738,055
1981	335,100	2,500	337,600	274,300	39,800	314,100	64,172	3,216	67,388	18,700	18,053	710,325	45,516	755,841
1982	340,400	4,100	344,500	257,800	20,800	278,600	35,033	450	35,483	37,600	21,076	691,909	25,350	717,259
1983	315,100	22,300	337,400	245,400	9,000	254,400	40,889	96	40,985	49,000	14,853	665,242	31,396	696,638
1984	306,100	1,600	307,700	176,100	10,500	186,600	39,374	202	39,576	93,900	20,308	635,782	12,302	648,084
1985	388,140	2,735	390,875	75,043	1,800	76,843	46,790	3,656	50,446	78,000	18,111	606,084	8,191	614,275
1986	104,100		104,100	128,499		128,499	236,309	7,431	243,740	101,000	24,789	594,697	7,431	602,128
1987	183,700		183,700	100,300		100,300	290,829	10,789	301,618	47,000	22,187	644,016	10,789	654,805
1988	115,600	3,100	118,700	75,600	2,700	78,300	308,550	29,766	338,316	116,200	24,772	640,722	35,566	676,288
1989	121,300	2,600	123,900	72,900	2,300	75,200	279,410	2,190	281,600	86,900	18,321	578,831	7,090	585,921
1990	114,800	5,800	120,600	56,300	5,500	61,800	300,800	4,300	305,100	116,800	21,311	610,011	15,600	625,611
1991	109,500	10,700	120,200	50,500	12,800	63,300	358,700	7,200	365,900	97,800	20,683	637,183	30,700	667,883
1992	141,906	9,620	151,526	72,153	12,400	84,553	364,184	2,980	367,164	139,062	18,046	735,351	25,000	760,351
1993	133,497	2,670	136,167	99,828	12,790	112,618	387,838	2,720	390,558	165,973	19,720	806,856	18,180	825,036
1994	134,338	1,390	135,728	113,088	2,830	115,918	474,830	1,150	475,980	69,900	25,043	817,198	5,370	822,568
1995	145,626	74	145,700	117,883	6,917	124,800	322,670	730	323,400	134,100	27,600	747,879	7,721	755,600
1996	129,895	255	130,150	73,351	9,773	83,124	211,451	1,387	212,838	103,376	34,123	552,196	11,415	563,611
1997*	65,044	2,240	67,284	114,719	13,817	128,536	224,759	2,807	227,566	105,449	40,708	550,679	18,864	569,543

*Preliminary.
[1]For 1976–1985 only Division IIa.
[2]Discards estimated only for one fleet in recent years.

NB: Landings from 1969–1978 were taken from the 1978 Working Group report (Tables 2.1, 2.2 and 2.5).

Table 2.2.2.2 Catches (t) of MACKEREL in the Norwegian Sea (Division IIa) and off the Faroes (Division Vb). (Data submitted by Working Group members.)

Country	1984	1985	1986	1987	1988	1989
Denmark	11,787	7,610	1,653	3,133	4,265	6,433
Faroe Islands	137				22	1,247
France		16				11
Germany, Fed. Rep.			99		380	
German Dem. Rep.			16	292		2,409
Norway	82,005	61,065	85,400	25,000	86,400	68,300
Poland						
United Kingdom			2,131	157	1,413	
USSR	4,293	9,405	11,813	18,604	27,924	12,088
Discards						
Total	98,222	78,096	101,112	47,186	120,404	90,488

Country	1990	1991	1992	1993	1994	1995	1996	1997[1]
Denmark	6,800	1,098	251			4,746	3,198	37
Estonia			216		3,302	1,925	3,741	4,422
Faroe Islands	3,100	5,793	3,347	1,167	6,258	9,032	2,965	7,628
France		23	6	6	5	5	0	270
Germany							1	-
Iceland							92	925
Latvia			100	4,700	1,508	389	233	-
Netherlands							561	-
Norway	77,200	76,760	91,900	110,500	140,708	93,315	47,992	41,000
Russia			42,440	49,600	28,041	44,537	44,545	50,207
United Kingdom	400	514	802		1,706	194	48	938
USSR[2]	28,900	13,631[2]						
Poland								22
Misreported (IVa)					-109,625	-18,647	-	-
Discards	2,300						-	-
Total	118,700	97,819	139,062	165,973	71,903	135,496	103,376	105,449

[1]Preliminary.
[2]Russia.

Table 2.2.2.3 Catch (t) of MACKEREL in the North Sea, Skagerrak, and Kattegat (Sub-area IV and Division IIIa). (Data submitted by Working Group members).

Country	1984	1985	1986	1987	1988	1989	1990
Belgium	68		49	14	20	37	
Denmark	10,088	12,424	23,368	28,217	32,588	26,831	29,000
Estonia							
Faroe Islands		1,356				2,685	5,900
France		322	1,200	2,146	1,806	2,200	1,600
Germany, Fed. Rep.	112	217	1,853	474	177	6,312	3,500
Ireland						8,880	12,800
Latvia							
Netherlands	340	726	1,949	2,761	2,564	7,343	13,700
Norway	27,311	30,835	50,600	108,250	59,750	81,400	74,500
Sweden	1,440	760	1,300	3,162	1,003	6,601	6,400
United Kingdom	15	170	559	19857	1,002	38,660	30,800
USSR (Russia from 1990)							
Romania							
Misreported (IIa)							
Misreported (VIa)			148,000	117,000	180,000	92,000	126,000
Unallocated	-	-	7,391	8,948	29,630	6,461	-3,400
Discards	202	3,656	7,431	10,789	29,776	2,190	4,300
Total	39,576	50,466	243,700	301,618	338,316	281,600	305,100

Country	1991	1992	1993	1994	1995	1996	1997[1]
Belgium	125	102	191	351	106	62	114
Denmark	38,834	41,719	42,502	47,852	30,891	24,057	21,934
Estonia		400					-
Faroe Islands	5,338		11,408	11,027	17,883	13,886	1,367
France	2,362	956	1,480	1,570	1,599	1,316	1,532
Germany, Fed. Rep.	4,173	4,610	4,940	1,479	712	542	213
Ireland	13,000	13,136	13,206	9,032	5,607	5,280	280
Latvia		211					-
Netherlands	4,591	6,547	7,770	3,637	1,275	1,996	951
Norway	102,350	115,700	112,700	115,741	108,785	88,444	96,300
Sweden	4,227	5,100	5,934	7,099	6,285	5,307	4,714
United Kingdom	36,917	35,137	41,010	27,479	21,609	18,545	19,204
Russia							3,525
Romania				2,903			-
Misreported (IIa)				109,625	18,647	-	-
Misreported (VIa)	130,000	127,000	146,697	134,765	106,987	51,781	73,523
Unallocated	16,758	13,566	-	-	983	236	1,102
Discards	7,200	2,980	2,720	1,150	730	1,387	2,807
Total	365,875	367,164	390,558	473,977	322,099	212,839	227,566

[1] Preliminary.

Table 2.2.2.4 Catch (t) of MACKEREL in the Western area (Sub-areas VI and VII and Divisions VIIIa,b,d,e). (Data submitted by Working Group members).

Country	1984	1985	1986	1987	1988	1989	1990
Denmark	200	400	300	100		1,000	
Faroe Islands	9,200	9,900	1,400	7,100	2,600	1,100	1,000
France	12,500	7,400	11,200	11,100	8,900	12,700	17,400
Germany	11,200	11,800	7,700	13,300	15,900	16,200	18,100
Ireland	84,100	91,400	74,500	89,500	85,800	61,100	61,500
Netherlands	99,000	37,000	58,900	31,700	26,100	24,000	24,500
Norway	34,700	24,300	21,000	21,600	17,300	700	
Poland							
Spain	100				1,500	1,400	400
United Kingdom	198,300	205,900	156,300	200,700	208,400	149,100	162,700
USSR	200						
Unallocated	18000	75100	49299	26000	4700	18900	11,500
Misreported (IVa)			-148,000	-117,000	-180,000	-92,000	-126,000
Discards	12,100	4,500			5,800	4,900	11,300
Grand Total	479,600	467,700	232,599	284,100	197,000	199,100	182,400

Country	1991	1992	1993	1994	1995	1996	1997[1]
Denmark	1,573	194		2,239	1,443	1,271	-
Estonia					361		-
Faroe Islands	4,095		2,350	4,283	4,248	-	2,158
France	10,364	9,109	8,296	9,998	10,178	14,347	19,114
Germany	17,138	21,952	23,776	25,011	23,703	15,685	15,161
Ireland	64,827	76,313	81,773	79,996	72,927	49,033	52,849
Netherlands	29,156	32,365	44,600	40,698	34,514	34,203	22,749
Norway			600	2,552			-
Spain	4,020	2,764	3,162	4,126	4,509	2,271	7,842
United Kingdom	162,588	196,890	215,265	208,656	190,344	127,612	128,836
Unallocated	-3,802	1,472	0	4,632	28,245	10,603	4,577
Misreported (IVa)	-130,000	-127,000	-146,697	-134,765	-106,987	-51,781	-73,523
Discards	23,550	22,020	15,660	4,220	6,991	10,028	16,057
Grand Total	183,509	236,079	248,785	251,646	270,476	213,272	195,820

[1]Preliminary

Table 2.2.2.5 Landings (tonnes) of mackerel in Divisions VIIIc and IXa, 1977–1997. Data submitted by Working Group members.

Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Spain[1]	19,852	18,543	15,013	11,316	12,834	15,621	10,390	13,852	11,810	16,533
Portugal[2]	1,743	1,555	1,071	1,929	3,108	3,018	2,239	2,250	4,178	6,419
Spain[2]	2,935	6,221	6,280	2,719	2,111	2,437	2,224	4,206	2,123	1,837
Poland[2]	8	-	-	-	-	-	-	-	-	-
USSR[2]	2,879	189	111	-	-	-	-	-	-	-
Total[2]	7,565	7,965	7,462	4,648	5,219	5,455	4,463	6,456	6,301	8,256
TOTAL	27,417	26,508	22,475	15,964	18,053	21,076	14,853	20,308	18,111	24,789

[1]Division VIIIc.

[2]Division IXa.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Spain[1]	15,982	16,844	13,446	16,086	16,940	12,043	16,675	21,146	23,631	28,386	35,015
Portugal[2]	5,714	4,388	3,112	3,819	2,789	3,576	2,015	2,158	2,893	3,023	2,080
Spain[2]	491	3,540	1,763	1,406	1,051	2,427	1,027	1,741	1,025	2,714	3,613
Poland[2]	-	-	-	-	-	-	-	-	-	-	-
USSR[2]	-	-	-	-	-	-	-	-	-	-	-
Total[2]	6,205	7,928	4,875	5,225	3,840	6,003	3,042	3,899	3,918	6,737	5,693
TOTAL	22,187	24,772	18,321	21,311	20,780	18,046	19,719	25,045	27,549	34,123	40,708

[1]Division VIIIc.

[2]Division IXa.

Table 2.2.2.6 Catches of mackerel by Division and Sub-area in 1996.
(Data submitted by Working Group members.)

Quarter	1	2	3	4	Total
IIa + Vb	2,000	4,300	97,300	1,900	10,500
IIIa	2,500	300	4,100	1,200	8,100
IVa	76,000	4,100	60,800	74,800	215,700
IVb,c	800	100	1,700	800	3,400
VI	47,700	4,800	1,300	13,900	67,600
VII	42,800	25,000	15,000	31,800	114,600
VIIIa,b,d,e	7,000	6,400	400	200	14,000
Sub-total	178,800	45,000	180,600	124,600	528,900
VIIIc	13,000	18,100	2,100	1,800	35,000
IXa	1,600	1,200	1,900	1,000	5,700
Grand total	193,400	41,800	184,600	127,500	569,600

Catches rounded to nearest 100.

Table 2.4.1.1 catch numbers at at age (000's) for NE Atlantic mackerel

Quarter 1

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	28	2,630	0	0	5	1,076	0	0	1	43	0	337	0	0	90	364	462	1,587	12,870	19,492
2	22	299	4,188	879	0	0	74	1,425	2	1,951	120	4,508	0	4,545	410	11	158	640	1,345	1,797	1,605	23,981
3	91	649	16,734	308	0	0	427	6,090	3	3,080	183	6,873	4	3,276	5,978	72	610	2,464	2,179	557	301	49,878
4	212	2,445	54,899	161	0	0	1,098	32,456	2	5,739	131	4,925	16	2,833	28,166	385	1,699	6,862	10,383	1,338	372	154,121
5	166	1,248	37,349	64	0	0	769	34,169	0	3,457	21	784	6	718	14,711	250	735	2,971	6,537	441	174	104,570
6	61	699	25,429	16	0	0	410	12,665	0	3,569	12	456	6	307	9,686	113	250	1,011	2,149	81	59	56,976
7	40	250	14,443	0	0	0	266	8,323	0	3,153	10	379	4	312	6,100	73	190	766	2,381	71	50	36,808
8	23	349	13,656	32	0	0	284	7,585	0	1,381	1	25	1	34	3,566	67	154	624	2,071	48	38	29,940
9	10	150	8,886	0	0	0	176	3,518	0	994	1	25	1	86	2,200	33	105	425	1,767	28	14	18,419
10	7	0	6,602	0	0	0	76	3,123	0	737	0	0	0	0	555	6	46	186	988	10	10	12,346
11	3	100	4,079	0	0	0	27	1,787	0	442	0	0	0	0	202	5	38	154	563	6	3	7,410
12	2	0	2,396	0	0	0	50	918	0	55	2	57	0	28	0	0	25	100	442	2	5	4,082
13	0	0	1,418	0	0	0	5	1,081	0	93	0	0	0	0	0	0	12	47	132	0	0	2,789
14	0	50	590	0	0	0	2	1,106	0	126	0	0	0	0	0	0	1	7	68	0	0	1,951
15+	1	0	1,161	0	0	0	5	707	0	6	1	27	0	33	0	0	5	21	79	0	0	2,045
SOP	287	2,526	75,939	823	0	0	1,670	47,285	2	9,692	99	3,730	13	2,751	26,105	393	1,381	5,582	11,742	1,208	1,624	192,859
Catch	287	2,533	75,958	826	0	0	1,670	47,291	2	9,712	99	3,727	13	2,751	26,107	393	1,382	5,582	11,746	1,208	1,624	192,911
SOP%	100%	100%	100%	100%			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Quarter 2

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	8	1	10	453	3	0	9	123	0	28	113	2	0	522	0	0	98	56	56	1,217	2,253	4,951
2	66	11	594	151	0	0	119	0	0	321	18	219	0	1,268	322	0	171	83	608	4,592	885	9,431
3	467	58	1,676	53	0	0	745	918	0	3,166	14	335	3	0	3,756	0	659	1,103	2,187	697	347	16,184
4	1,408	149	3,133	28	0	0	1,916	1,969	0	7,247	2	240	7	75	13,231	0	1,835	3,646	11,133	1,778	599	48,396
5	947	121	1,786	11	0	0	1,224	2,704	0	3,882	0	38	6	0	10,935	0	794	2,183	8,328	899	354	34,214
6	375	88	806	3	0	0	498	2,119	0	3,292	0	22	1	0	4,768	0	270	1,276	3,328	275	176	17,298
7	291	51	528	0	0	0	368	1,931	0	3,009	0	18	1	0	3,750	0	205	1,217	3,768	273	195	15,606
8	354	46	587	6	0	0	450	1,291	0	807	0	1	1	0	4,057	0	167	1,068	3,321	228	159	12,542
9	281	19	395	0	0	0	345	726	0	693	2	1	1	0	3,284	0	114	790	2,765	176	103	9,695
10	48	21	93	0	0	0	60	524	0	359	0	0	0	0	900	0	50	323	1,552	103	71	4,104
11	30	5	51	0	0	0	38	194	0	366	0	0	0	0	732	0	41	241	931	67	29	2,725
12	0	20	30	0	0	0	2	342	0	112	0	3	0	0	786	0	27	185	769	52	34	2,362
13	0	2	2	0	0	0	0	161	0	284	0	0	0	0	169	0	13	84	195	12	5	928
14	0	1	1	0	0	0	0	62	0	66	0	0	0	0	443	0	2	14	105	7	3	703
15+	0	1	2	0	0	0	0	24	0	174	0	1	0	0	172	0	5	14	152	17	2	565
SOP	1,846	291	4,091	142	1	0	2,488	4,850	0	7,946	26	182	6	179	16,695	0	1,492	4,882	15,639	2,453	1,155	64,369
Catch	1,846	291	4,091	142	1	0	2,489	4,832	0	7,946	27	181	6	179	16,699	0	1,493	4,883	15,644	2,456	1,159	64,364
SOP%	100%	100%	100%	100%	101%		100%	100%		100%	100%	100%	100%	100%	100%		100%	100%	100%	100%	100%	100%

Table 2.4.1.1 (continued) catch numbers at at age (000's) for NE Atlantic mackerel

Quarter 3

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIe/f	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0	0	0	0	0	0	0	2,138	0	25	190	84	0	3,545	0	0	0	0	420	0	12,178	18,580
1	0	5	11,651	6,931	3,448	0	4	3,208	0	1,289	5,901	2,829	2	6,648	147	0	0	0	1,873	552	1,098	45,586
2	10,271	168	8,309	2,328	544	0	143	1,367	1	1,014	15,998	10,540	8	944	313	0	16	0	619	7,328	1,614	61,526
3	45,954	829	13,988	844	423	0	708	1,069	0	690	6,592	2,667	7	631	337	0	102	2	95	801	446	76,184
4	72,474	2,123	29,945	540	61	0	1,817	395	0	355	2,531	2,128	2	2,179	280	0	285	6	78	462	88	115,747
5	41,355	1,734	23,942	243	0	0	1,486	92	0	77	507	594	1	1,261	165	0	157	3	21	72	213	71,923
6	17,836	1,251	17,028	71	0	0	1,073	17	0	45	333	588	0	745	133	0	90	2	7	19	149	39,385
7	9,699	723	9,761	14	0	0	618	15	0	30	262	10	0	745	0	0	84	2	7	15	22	22,008
8	8,076	647	8,968	95	0	0	556	4	0	79	214	8	0	631	78	0	74	2	5	12	12	19,453
9	3,211	264	3,559	1	61	0	226	3	0	38	65	2	0	459	26	0	54	1	3	7	6	7,988
10	1,588	307	4,126	8	0	0	261	1	0	32	94	4	0	172	0	0	23	0	2	4	30	6,653
11	913	72	999	7	0	0	62	12	0	12	49	2	0	115	0	0	17	0	1	2	1	2,264
12	689	283	3,808	0	0	0	242	3	0	18	25	1	0	115	0	0	13	0	1	2	0	5,200
13	26	34	454	0	0	0	29	0	0	6	33	1	0	57	0	0	6	0	0	0	0	647
14	0	14	183	0	0	0	12	2	0	6	10	0	0	0	0	0	1	0	0	0	0	229
15+	150	19	288	0	0	0	18	2	0	6	5	0	0	0	26	0	1	0	0	0	0	516
SOP	92,546	4,143	60,743	2,284	811	0	3,550	1,285	0	763	7,253	4,967	5	4,243	390	0	358	7	509	1,588	1,861	187,307
Catch	92,546	4,145	60,756	2,300	813	0	3,550	1,286	0	762	7,158	4,966	5	1,731	390	0	357	8	508	1,588	1,862	184,731
SOP%	100%	100%	100%	101%	100%		100%	100%		100%	98%	100%	100%	41%	100%		100%	100%	100%	100%	100%	99%

Quarter 4

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIe/f	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0	0	17	0	0	0	0	630	0	0	0	167	0	924	0	0	21	1	6,904	222	8,545	17,432
1	0	14	5,565	171	1,177	10	19	5,293	1	1,259	1,819	25,504	9	27,638	109	0	143	4	2,937	2,066	626	74,361
2	123	219	19,105	112	261	21	39	14,833	1	5,141	1,383	37,258	41	9,900	510	0	42	1	914	841	800	91,542
3	516	444	49,268	264	131	51	97	18,072	1	5,428	554	15,612	40	4,843	501	0	12	0	120	112	114	96,181
4	1,200	617	39,248	202	349	39	74	8,026	0	2,979	464	5,047	10	2,037	129	0	18	0	73	84	19	60,617
5	941	500	30,380	176	87	31	58	1,768	0	486	279	1,169	5	0	57	0	41	1	26	26	43	36,073
6	343	290	18,204	83	87	21	40	928	0	155	92	1,023	1	4	17	0	52	1	11	6	39	21,399
7	225	151	8,870	29	0	13	24	298	0	27	0	80	0	0	0	0	109	3	14	7	5	9,956
8	133	126	3,523	9	0	5	9	101	0	0	0	525	0	44	0	0	66	2	14	6	5	4,568
9	56	93	2,983	5	0	2	3	54	0	46	0	27	0	0	0	0	57	1	13	4	3	3,348
10	39	56	2,851	13	0	4	7	100	0	11	0	523	0	0	0	0	17	0	8	2	0	3,632
11	19	11	1,466	4	0	3	5	12	0	11	0	0	0	0	0	0	14	0	5	1	0	1,552
12	12	48	2,065	5	44	3	6	114	0	0	0	10	0	0	0	0	0	0	5	1	0	2,312
13	1	14	357	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	375
14	0	7	115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	122
15+	5	3	3	0	44	0	0	93	0	0	0	0	0	0	0	0	0	0	1	0	0	147
SOP	1,627	1,207	75,760	394	502	81	153	13,835	1	4,249	1,142	18,571	27	7,398	337	0	205	5	1,263	598	1,046	128,395
Catch	1,627	1,173	74,884	387	504	81	153	13,874	1	4,249	1,143	18,596	27	7,410	337	0	204	5	1,263	600	1,046	128,564
SOP%	100%	97%	99%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%		99%	94%	100%	100%	100%	100%

Quarter 1-4

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIe/f	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0	0	17	0	0	0	0	2,768	0	25	190	251	0	4,470	0	0	21	1	7,324	222	20,724	36,012
1	8	19	17,254	10,186	4,628	10	37	9,700	1	2,576	7,833	28,377	10	35,145	256	0	330	423	5,329	5,421	16,847	144,390
2	10,482	697	32,197	3,470	806	21	375	17,625	5	8,427	17,519	52,525	49	16,657	1,555	11	387	725	3,486	14,558	4,905	186,481
3	47,028	1,980	81,666	1,469	555	51	1,978	26,150	4	12,364	7,342	25,487	54	8,750	10,572	72	1,383	3,569	4,581	2,167	1,207	238,426
4	75,294	5,334	127,225	931	409	39	4,905	42,845	3	16,321	3,127	12,340	35	7,124	41,806	385	3,836	10,514	21,667	3,661	1,078	378,881
5	43,409	3,604	93,457	494	87	31	3,537	38,732	0	7,902	807	2,585	17	1,979	25,868	250	1,728	5,159	14,912	1,439	784	246,781
6	18,614	2,327	61,486	172	87	21	2,021	15,728	0	7,061	437	2,088	9	1,057	14,604	113	663	2,290	5,495	381	424	135,059
7	10,255	1,175	33,702	43	0	13	1,276	10,568	0	6,220	272	487	5	1,057	9,849	73	588	1,988	6,169	366	271	84,378
8	8,586	1,168	26,733	142	0	5	1,299	8,982	0	2,260	215	559	2	710	7,701	67	462	1,895	5,411	293	215	66,504
9	3,558	525	15,823	6	61	2	751	4,301	0	1,772	68	55	2	545	5,509	33	330	1,218	4,549	216	126	39,450
10	1,682	384	13,672	21	0	4	405	3,748	0	1,140	94	526	1	172	1,455	6	136	510	2,550	119	112	26,735
11	965	188	6,594	10	0	3	132	2,005	0	831	49	2	0	115	934	5	111	396	1,500	76	32	13,950
12	703	351	8,299	5	44	3	300	1,376	0	186	27	70	0	143	786	0	64	285	1,218	56	40	13,956
13	28	50	2,231	0	0	0	34	1,242	0	384	33	1	0	57	169	0	30	132	329	13	5	4,739
14	0	72	888	0	0	0	14	1,170	0	199	10	0	0	0	443	0	5	20	174	7	3	3,005
15+	155	23	1,453	0	44	0	23	826	0	186	5	28	0	33	198	0	12	35	232	17	3	3,273
SOP	96,309	8,186	216,527	3,642	1,313	81	7,861	67,259	3	22,651	8,521	27,448	51	14,568	43,527	393	3,437	10,478	29,152	5,847	5,684	572,917
Catch	96,306	8,142	215,650	3,655	1,319	81	7,862	67,283	3	22,669	8,427	27,471	51	12,073	43,553	393	3,437	10,478	29,162	5,853	5,692	569,543
SOP%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	98%	100%	100%	83%	100%	100%	100%	100%	100%	100%	100%	99%

Table 2.4.1.2 North East Atlantic Mackerel 1997 Quarter 1-4 percentage catch numbers at age

	Quarter 1-4																					
Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	Total
0	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	6%	0%	0%	0%	0%	9%	1%	44%	2%
1	0%	0%	3%	60%	69%	5%	0%	5%	10%	4%	21%	23%	6%	45%	0%	0%	3%	1%	6%	19%	36%	9%
2	5%	4%	6%	20%	12%	10%	2%	9%	32%	12%	46%	42%	26%	21%	1%	1%	4%	3%	4%	50%	10%	11%
3	21%	11%	16%	9%	8%	25%	12%	14%	31%	18%	19%	20%	29%	11%	9%	7%	14%	12%	5%	7%	3%	15%
4	34%	30%	24%	5%	6%	19%	29%	23%	19%	24%	8%	10%	19%	9%	34%	38%	38%	36%	26%	13%	2%	23%
5	20%	20%	18%	3%	1%	15%	21%	21%	3%	12%	2%	2%	9%	3%	21%	25%	17%	18%	18%	5%	2%	15%
6	8%	13%	12%	1%	1%	11%	12%	8%	2%	10%	1%	2%	5%	1%	12%	11%	7%	8%	6%	1%	1%	8%
7	5%	7%	6%	0%	0%	6%	7%	6%	1%	9%	1%	0%	3%	1%	8%	7%	6%	7%	7%	1%	1%	5%
8	4%	7%	5%	1%	0%	2%	8%	5%	0%	3%	1%	0%	1%	1%	6%	7%	5%	6%	6%	1%	0%	4%
9	2%	3%	3%	0%	1%	1%	4%	2%	0%	3%	0%	0%	1%	1%	5%	3%	3%	4%	5%	1%	0%	2%
10	1%	2%	3%	0%	0%	2%	2%	2%	0%	2%	0%	0%	0%	0%	1%	1%	1%	2%	3%	0%	0%	2%
11	0%	1%	1%	0%	0%	1%	1%	1%	0%	1%	0%	0%	0%	0%	1%	1%	1%	1%	2%	0%	0%	1%
12	0%	2%	2%	0%	1%	2%	2%	1%	0%	0%	0%	0%	0%	0%	1%	0%	1%	1%	1%	0%	0%	1%
13	0%	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
14	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15+	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 2.4.2.1 MACKEREL length distributions in 1997 catches by country and by various fleets.

Length	Portugal		Spain			Netherlands	Ireland	Norway[1]	Scotland	England		Russia
(cm)	artisanal	trawl	artisanal	purse seine	trawl	pel. trawl	trawl	purse seine	all gears	lines	trawl	all gears
17						0%	0%					
18						0%	0%					
19			0%	0%		0%	0%					
20		0%	0%	1%	0%	0%	1%			0%		
21	0%	0%	0%	6%	0%	1%	0%		0%	0%		
22	0%	3%	0%	16%	3%	0%	0%			0%	0%	
23	1%	3%	0%	10%	6%	1%	0%			0%	0%	
24	1%	2%	0%	2%	4%	0%	0%		0%	0%	2%	
25	2%	1%	0%	1%	3%	3%	1%			1%	6%	
26	1%	2%	0%	1%	2%	5%	1%		0%	2%	8%	
27	3%	8%	0%	3%	4%	3%	1%		0%	3%	9%	
28	6%	17%	1%	7%	13%	2%	1%		0%	5%	9%	0%
29	12%	19%	1%	5%	14%	4%	2%	0%	1%	10%	15%	0%
30	11%	14%	1%	2%	6%	4%	4%	1%	3%	11%	14%	1%
31	12%	8%	2%	1%	4%	4%	8%	3%	3%	8%	11%	5%
32	11%	4%	2%	2%	3%	4%	9%	5%	6%	10%	10%	8%
33	10%	3%	4%	3%	4%	5%	9%	8%	9%	10%	5%	10%
34	8%	2%	6%	6%	6%	8%	10%	14%	15%	11%	4%	14%
35	6%	3%	12%	7%	7%	11%	11%	17%	14%	9%	3%	17%
36	5%	3%	15%	7%	6%	10%	10%	20%	14%	6%	1%	16%
37	4%	3%	13%	5%	3%	9%	7%	12%	11%	5%	0%	12%
38	2%	2%	11%	3%	2%	7%	6%	9%	6%	3%	0%	6%
39	2%	1%	10%	3%	4%	5%	5%	7%	5%	2%	0%	4%
40	1%	1%	8%	3%	2%	4%	4%	3%	4%	1%	0%	3%
41	1%	0%	6%	3%	2%	4%	3%	1%	3%	0%		2%
42	0%	0%	5%	1%	1%	2%	2%	0%	2%	0%		1%
43	0%	0%	2%	0%	1%	1%	1%	0%	1%	0%		0%
44	0%	0%	1%	0%	0%	1%	0%	0%	1%			0%
45	0%	0%	0%	0%	0%	0%	0%	0%	0%			
46									0%			
47												0%
48												
49												
50												

[1]Length distributions may not reflect seasonal variations

[2] 0% reflects a value greater than zero but less than 0.5%

Table 2.4.3.1 Mean length at age for NE Atlantic mackerel

Quarter 1

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	29.4	27.0	0.0	0.0	21.5	21.5	27.5	0.0	27.5	27.5	0.0	23.9	0.0	0.0	22.7	22.7	23.7	23.6	22.8	23.4
2	31.9	29.8	30.2	31.2	0.0	0.0	31.7	29.8	28.6	30.6	28.6	28.6	0.0	27.3	30.6	30.6	29.9	29.9	29.6	29.1	28.8	29.2
3	33.2	32.4	32.1	33.0	0.0	0.0	33.5	31.3	30.8	32.2	30.8	30.8	33.2	30.7	33.1	33.0	34.0	34.0	34.4	32.3	32.1	32.1
4	35.0	35.4	34.6	36.5	0.0	0.0	35.2	34.5	33.0	35.2	33.0	33.0	34.7	33.4	35.0	35.3	35.1	35.1	35.5	34.5	34.7	34.7
5	36.1	37.1	36.0	37.0	0.0	0.0	36.6	36.5	34.8	37.1	34.8	34.8	36.5	35.5	36.7	36.8	36.3	36.3	36.9	35.8	36.0	36.3
6	36.9	38.4	36.9	37.5	0.0	0.0	37.6	37.3	34.5	38.2	34.5	34.5	36.8	35.5	37.5	38.5	37.9	37.9	38.3	37.0	36.8	37.2
7	37.8	40.5	38.3	0.0	0.0	0.0	39.0	38.6	33.7	39.8	33.7	33.7	38.7	34.7	39.2	39.9	39.1	39.1	39.4	38.5	37.9	38.7
8	39.2	40.9	38.9	38.5	0.0	0.0	38.9	39.9	39.5	40.7	39.5	39.5	40.1	39.5	40.6	40.8	40.0	40.0	40.0	38.8	38.5	39.5
9	39.3	41.2	39.8	0.0	0.0	0.0	40.6	40.4	39.5	41.0	39.5	39.5	40.6	40.1	41.6	42.3	41.0	41.0	41.0	39.9	39.5	40.4
10	40.3	0.0	40.4	0.0	0.0	0.0	40.4	41.0	0.0	42.0	0.0	0.0	40.9	0.0	39.9	38.5	41.3	41.3	41.5	40.0	40.2	40.7
11	41.0	43.0	40.7	0.0	0.0	0.0	41.0	42.3	0.0	43.0	0.0	0.0	0.0	0.0	43.5	43.5	41.3	41.3	41.7	39.9	41.8	41.4
12	41.7	0.0	41.6	0.0	0.0	0.0	41.3	42.8	35.5	43.6	35.5	35.5	0.0	35.5	0.0	0.0	42.3	42.3	42.7	41.0	43.7	41.9
13	45.0	0.0	40.8	0.0	0.0	0.0	41.7	41.5	0.0	43.1	0.0	0.0	0.0	0.0	0.0	0.0	42.8	42.8	43.0	42.5	41.6	41.3
14	0.0	43.5	43.5	0.0	0.0	0.0	43.1	40.2	0.0	44.5	0.0	0.0	0.0	0.0	0.0	0.0	44.5	44.5	44.2	43.1	0.0	41.7
15+	44.0	0.0	42.1	0.0	0.0	0.0	42.8	42.9	36.5	46.5	36.5	36.5	0.0	36.5	0.0	0.0	45.2	45.2	44.0	42.9	41.5	42.3

Quarter 2

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	19.5	27.1	19.9	27.0	26.8	0.0	19.5	20.7	0.0	18.2	26.8	27.5	0.0	20.2	0.0	0.0	22.7	22.8	25.0	26.2	24.5	24.6
2	30.9	31.9	31.6	31.2	30.8	0.0	31.5	0.0	0.0	30.2	30.8	28.6	28.6	26.8	28.6	0.0	29.9	32.1	31.0	28.3	28.9	26.8
3	33.6	33.6	33.3	33.0	32.8	0.0	33.5	32.4	0.0	31.5	32.8	30.8	30.4	34.4	31.2	0.0	34.0	34.4	34.6	32.5	32.7	32.6
4	35.2	35.3	34.9	36.5	35.5	0.0	35.2	34.6	0.0	34.3	35.5	33.0	32.7	31.5	33.6	0.0	35.1	35.7	35.7	34.9	34.8	34.7
5	36.8	36.2	36.6	37.0	0.0	0.0	36.8	36.1	0.0	36.2	0.0	34.8	36.3	37.1	36.4	0.0	36.3	37.1	37.1	36.7	36.6	36.6
6	38.6	37.1	38.0	37.5	0.0	0.0	38.3	36.8	0.0	37.3	0.0	34.5	37.7	39.0	37.1	0.0	37.9	39.0	38.6	38.1	37.7	37.7
7	40.2	37.8	39.4	0.0	0.0	0.0	40.1	38.3	0.0	38.8	0.0	33.7	39.7	39.7	39.9	0.0	39.1	39.7	39.5	39.2	38.7	39.3
8	38.9	38.8	39.0	38.5	0.0	0.0	38.9	39.6	0.0	39.7	0.0	39.5	38.5	40.5	39.0	0.0	40.0	40.5	40.1	39.8	39.3	39.5
9	41.0	39.5	40.7	0.0	35.5	0.0	41.0	39.8	0.0	41.2	35.5	39.5	39.2	41.2	40.4	0.0	41.0	41.2	41.0	40.9	40.4	40.7
10	42.0	39.8	40.9	0.0	0.0	0.0	41.8	40.8	0.0	40.3	0.0	0.0	41.6	41.1	41.7	0.0	41.3	41.1	41.5	41.5	41.0	41.3
11	41.5	40.4	41.5	0.0	0.0	0.0	41.5	41.9	0.0	41.6	0.0	0.0	41.9	41.3	41.5	0.0	41.3	41.3	41.9	42.0	41.6	41.7
12	0.0	41.3	41.2	0.0	0.0	0.0	41.0	41.3	0.0	41.5	0.0	35.5	39.5	42.1	40.7	0.0	42.3	42.1	42.8	43.0	42.8	41.7
13	0.0	41.7	41.7	0.0	0.0	0.0	0.0	38.8	0.0	42.8	0.0	0.0	0.0	0.0	42.5	0.0	42.8	42.7	43.1	43.2	43.2	42.1
14	0.0	43.1	43.1	0.0	0.0	0.0	0.0	40.0	0.0	44.5	0.0	0.0	0.0	0.0	43.9	0.0	44.5	44.5	44.1	44.1	43.9	43.7
15+	0.0	42.8	42.8	0.0	0.0	0.0	0.0	42.2	0.0	44.5	0.0	36.5	44.5	0.0	43.8	0.0	45.2	44.5	44.6	46.1	43.6	44.3

Table 2.4.3.1 (continued) Mean length at age for NE Atlantic mackerel

Quarter 3

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.4	22.6	19.5	22.6	19.5	0.0	22.6	0.0	0.0	0.0	0.0	21.2	0.0	22.6	22.2
1	0.0	27.1	27.0	27.0	26.8	0.0	23.3	25.9	27.4	26.9	27.4	27.0	28.9	26.4	27.1	0.0	0.0	0.0	28.8	28.0	28.5	27.0
2	32.4	31.9	31.0	31.2	30.8	0.0	31.8	29.9	29.7	29.6	29.7	29.3	31.6	29.2	29.6	0.0	31.1	31.1	30.0	28.8	30.9	30.2
3	33.3	33.6	33.3	33.0	32.8	0.0	33.6	31.2	31.0	30.6	31.0	30.0	32.4	34.4	30.4	0.0	33.9	33.9	32.2	30.4	34.3	32.8
4	34.9	35.3	35.3	36.4	35.5	0.0	35.3	35.1	33.3	32.4	33.3	31.3	34.7	35.7	32.7	0.0	35.4	35.4	33.6	32.8	34.9	34.9
5	36.1	36.2	36.2	36.9	0.0	0.0	36.4	36.6	35.7	35.7	35.7	35.7	34.7	37.1	34.2	0.0	37.0	37.0	36.9	36.3	36.1	36.2
6	37.2	37.1	37.1	37.4	0.0	0.0	37.3	39.0	36.8	36.4	36.8	36.8	36.4	39.0	35.3	0.0	38.9	38.9	38.2	37.7	37.5	37.2
7	37.9	37.8	37.8	36.2	0.0	0.0	38.3	36.8	37.5	36.9	37.5	37.5	0.0	39.7	0.0	0.0	39.7	39.7	39.0	38.9	37.4	37.9
8	39.3	38.8	38.8	38.5	0.0	0.0	38.8	38.7	38.0	38.3	38.0	38.0	0.0	40.5	38.8	0.0	40.5	40.5	39.5	39.3	39.0	39.0
9	39.3	39.5	39.5	38.5	35.5	0.0	40.1	38.9	37.5	39.1	37.4	37.5	0.0	41.2	31.5	0.0	41.2	41.2	40.7	40.5	39.2	39.5
10	39.5	39.8	39.8	37.1	0.0	0.0	40.0	37.1	38.6	39.6	38.6	38.6	0.0	41.1	0.0	0.0	41.1	41.1	41.1	40.9	40.0	39.7
11	41.4	40.4	40.3	36.2	0.0	0.0	40.7	38.3	38.8	43.0	38.8	38.8	0.0	41.3	0.0	0.0	41.3	41.3	41.4	41.0	41.7	40.8
12	41.3	41.3	41.3	0.0	0.0	0.0	41.3	37.0	41.8	39.5	41.8	41.8	0.0	42.1	0.0	0.0	42.1	42.1	42.7	42.7	43.3	41.3
13	45.0	41.7	41.7	0.0	0.0	0.0	41.7	0.0	37.8	41.5	37.8	37.8	0.0	42.7	0.0	0.0	42.7	42.7	43.5	43.5	41.5	41.7
14	0.0	43.1	43.1	0.0	0.0	0.0	43.1	40.6	39.5	44.5	39.5	39.5	0.0	0.0	0.0	0.0	44.5	44.5	44.0	44.0	0.0	43.0
15+	44.3	42.8	42.8	0.0	0.0	0.0	42.6	38.0	38.5	41.5	38.5	38.5	0.0	0.0	40.5	0.0	44.5	44.5	44.0	44.1	44.8	43.1

Quarter 4

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0.0	0.0	20.9	0.0	0.0	0.0	0.0	20.9	25.1	0.0	0.0	25.1	0.0	24.0	0.0	0.0	25.9	25.9	22.8	25.4	22.9	22.8
1	0.0	28.0	28.1	27.1	27.9	28.1	28.1	26.8	28.1	28.2	28.0	28.1	28.9	26.8	28.9	0.0	28.6	28.6	28.9	29.1	28.6	27.7
2	31.9	33.5	32.6	32.0	31.2	32.0	32.0	32.2	31.4	32.1	32.2	31.4	31.6	30.1	31.6	0.0	30.1	30.1	29.9	30.1	30.4	31.7
3	33.2	34.4	33.7	33.8	31.8	33.2	33.2	32.6	31.5	32.9	33.7	31.6	32.4	30.5	32.4	0.0	33.1	33.1	32.0	32.1	33.7	32.9
4	35.0	35.8	35.7	35.9	33.5	35.3	35.3	34.6	33.3	34.7	35.8	33.4	34.7	31.8	34.7	0.0	37.5	37.5	34.0	33.9	34.5	35.2
5	36.1	37.1	36.9	36.5	34.0	36.7	36.7	35.4	36.4	35.8	37.5	36.5	34.7	0.0	34.7	0.0	39.5	39.5	37.1	36.5	36.2	36.8
6	36.9	37.7	37.4	37.2	38.0	37.0	37.0	37.5	34.4	37.3	39.5	34.5	36.4	34.5	36.4	0.0	39.5	39.5	38.9	38.3	37.7	37.3
7	37.8	38.2	38.0	38.4	0.0	37.7	37.7	38.2	37.7	39.1	0.0	37.7	0.0	0.0	0.0	0.0	39.5	39.5	39.8	39.0	37.4	38.0
8	39.2	39.0	39.3	39.1	0.0	39.3	39.3	36.4	32.9	0.0	0.0	32.9	0.0	32.5	0.0	0.0	39.5	39.5	40.4	39.5	39.0	38.5
9	39.3	40.3	40.4	39.9	0.0	39.8	39.8	39.8	37.5	38.1	0.0	37.5	0.0	0.0	0.0	0.0	39.5	39.5	41.3	40.5	39.0	40.3
10	40.3	40.0	40.9	42.3	0.0	40.3	40.3	39.0	36.7	39.5	0.0	36.7	0.0	0.0	0.0	0.0	39.5	39.5	42.0	40.8	40.0	40.2
11	41.0	40.4	40.2	40.2	0.0	40.2	40.2	34.5	0.0	40.5	0.0	0.0	0.0	0.0	0.0	0.0	39.5	39.5	42.5	40.9	42.6	40.2
12	41.7	41.3	42.0	41.9	37.5	42.3	42.3	39.5	37.9	0.0	0.0	37.9	0.0	0.0	0.0	0.0	0.0	0.0	42.9	41.6	43.5	41.7
13	45.0	40.3	40.4	42.0	0.0	42.0	42.0	41.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.4	43.1	0.0	40.4
14	0.0	42.4	42.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.9	44.0	0.0	42.0
15+	44.0	42.8	46.5	0.0	37.5	0.0	0.0	46.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.7	43.5	0.0	43.6

Quarter 1-4

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0.0	0.0	20.9	0.0	0.0	0.0	0.0	20.5	23.5	19.5	22.6	20.9	0.0	22.9	0.0	0.0	25.9	25.9	22.5	25.4	22.7	22.5
1	19.5	27.7	27.4	27.0	27.1	28.1	24.5	26.9	27.9	27.4	27.5	27.8	28.9	26.6	27.9	0.0	25.2	22.8	28.4	26.7	23.7	26.8
2	32.4	31.5	31.9	31.2	30.9	32.0	31.7	31.8	29.7	31.4	29.9	30.8	31.6	29.0	30.3	30.6	29.9	30.1	30.0	28.8	29.8	30.7
3	33.3	33.4	33.3	33.2	32.6	33.2	33.5	32.2	30.9	32.2	31.2	31.1	32.4	30.9	32.3	33.0	34.0	34.1	34.4	31.6	33.2	32.7
4	34.9	35.4	35.1	36.3	33.8	35.3	35.2	34.5	33.0	34.7	33.6	32.9	34.3	33.6	34.5	35.3	35.2	35.3	35.6	34.5	34.8	34.8
5	36.2	36.6	36.3	36.7	34.0	36.7	36.5	36.4	35.0	36.6	36.3	35.8	35.9	36.5	36.6	36.8	36.5	36.7	37.0	36.4	36.3	36.4
6	37.3	37.6	37.1	37.3	38.0	37.0	37.6	37.2	34.7	37.8	37.3	34.5	36.9	38.0	37.4	38.5	38.2	38.5	38.5	37.8	37.5	37.3
7	37.9	38.4	38.1	38.4	0.0	37.7	38.9	38.5	34.1	39.3	37.3	34.4	38.9	38.2	39.5	39.9	39.3	39.5	39.4	39.0	38.4	38.5
8	39.2	39.5	38.9	38.5	0.0	39.3	38.9	39.8	36.2	40.3	38.0	33.3	39.3	40.0	39.8	40.8	40.0	40.3	40.0	39.6	39.1	39.3
9	39.4	40.1	39.9	39.9	35.5	39.8	40.5	40.3	38.9	40.9	37.4	38.5	39.9	41.0	40.8	42.3	40.8	41.1	41.0	40.8	40.2	40.3
10	39.6	39.8	40.3	42.2	0.0	40.3	40.3	40.9	37.1	41.4	38.6	36.7	41.2	41.1	41.1	38.5	41.1	41.2	41.5	41.4	40.6	40.5
11	41.4	41.8	40.6	39.9	0.0	40.2	40.9	42.2	38.8	42.4	38.8	38.8	41.9	41.3	41.9	43.5	41.1	41.3	41.8	41.8	41.6	41.2
12	41.3	41.3	41.6	41.9	37.5	42.3	41.3	42.1	35.9	41.9	41.4	35.9	39.5	40.8	40.7	0.0	42.3	42.2	42.7	42.9	42.9	41.6
13	45.0	41.3	40.9	42.0	0.0	42.0	41.7	41.2	37.8	42.9	37.8	37.8	0.0	42.7	42.5	0.0	42.8	42.7	43.1	43.2	43.1	41.5
14	0.0	43.3	43.2	0.0	0.0	0.0	43.1	40.2	39.5	44.5	39.5	39.5	0.0	0.0	43.9	0.0	44.5	44.5	44.1	44.1	43.9	42.3
15+	44.3	42.8	42.2	0.0	37.5	0.0	42.8	43.3	36.5	44.5	38.2	36.5	44.5	36.5	43.3	0.0	45.1	44.9	44.4	46.1	43.6	42.8

Table 2.4.3.2 Mean Weight at age (kg) in the catch for NE Atlantic mackerel

Quarter 1

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.000	0.000	0.185	0.149	0.000	0.000	0.086	0.072	0.138	0.000	0.138	0.138	0.000	0.101	0.000	0.000	0.079	0.079	0.092	0.087	0.078	0.089
2	0.309	0.187	0.210	0.254	0.000	0.000	0.287	0.186	0.157	0.187	0.157	0.157	0.000	0.153	0.189	0.189	0.189	0.189	0.182	0.168	0.185	0.180
3	0.352	0.267	0.260	0.294	0.000	0.000	0.342	0.231	0.196	0.239	0.196	0.196	0.254	0.217	0.254	0.254	0.284	0.284	0.294	0.239	0.253	0.246
4	0.427	0.361	0.335	0.424	0.000	0.000	0.399	0.329	0.240	0.327	0.240	0.240	0.297	0.279	0.312	0.326	0.314	0.314	0.322	0.291	0.304	0.323
5	0.473	0.437	0.383	0.413	0.000	0.000	0.445	0.400	0.280	0.397	0.280	0.280	0.352	0.336	0.375	0.389	0.349	0.349	0.363	0.328	0.350	0.385
6	0.496	0.470	0.412	0.393	0.000	0.000	0.523	0.434	0.275	0.441	0.275	0.275	0.362	0.338	0.400	0.450	0.401	0.401	0.413	0.367	0.388	0.417
7	0.527	0.561	0.463	0.000	0.000	0.000	0.539	0.479	0.256	0.506	0.256	0.256	0.434	0.313	0.467	0.508	0.442	0.442	0.450	0.414	0.426	0.467
8	0.577	0.618	0.492	0.500	0.000	0.000	0.526	0.554	0.408	0.535	0.408	0.408	0.489	0.458	0.515	0.527	0.475	0.475	0.474	0.424	0.450	0.513
9	0.608	0.577	0.535	0.000	0.000	0.000	0.604	0.568	0.408	0.538	0.408	0.408	0.511	0.480	0.578	0.631	0.514	0.514	0.511	0.462	0.486	0.544
10	0.640	0.000	0.559	0.000	0.000	0.000	0.625	0.596	0.000	0.573	0.000	0.000	0.525	0.000	0.495	0.450	0.526	0.526	0.529	0.469	0.522	0.563
11	0.643	0.651	0.562	0.000	0.000	0.000	0.619	0.666	0.000	0.635	0.000	0.000	0.000	0.000	0.562	0.562	0.526	0.526	0.542	0.463	0.574	0.590
12	0.725	0.000	0.612	0.000	0.000	0.000	0.699	0.696	0.296	0.653	0.296	0.296	0.000	0.333	0.000	0.000	0.566	0.566	0.579	0.505	0.689	0.621
13	0.800	0.000	0.572	0.000	0.000	0.000	0.692	0.631	0.000	0.630	0.000	0.000	0.000	0.000	0.000	0.000	0.584	0.584	0.595	0.565	0.526	0.598
14	0.000	0.667	0.690	0.000	0.000	0.000	0.760	0.570	0.000	0.799	0.000	0.000	0.000	0.000	0.000	0.000	0.660	0.660	0.647	0.592	0.000	0.627
15+	0.815	0.000	0.639	0.000	0.000	0.000	0.799	0.704	0.322	0.810	0.322	0.322	0.000	0.362	0.000	0.000	0.695	0.695	0.640	0.583	0.524	0.654

Quarter 2

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.056	0.171	0.062	0.149	0.149	0.000	0.056	0.064	0.000	0.033	0.149	0.138	0.000	0.046	0.000	0.000	0.079	0.079	0.112	0.121	0.098	0.102
2	0.258	0.293	0.276	0.254	0.243	0.000	0.283	0.000	0.000	0.180	0.243	0.157	0.139	0.111	0.139	0.000	0.189	0.234	0.208	0.154	0.183	0.168
3	0.327	0.356	0.338	0.294	0.283	0.000	0.334	0.243	0.000	0.208	0.283	0.196	0.172	0.295	0.200	0.000	0.284	0.295	0.297	0.243	0.268	0.255
4	0.378	0.432	0.390	0.424	0.395	0.000	0.382	0.296	0.000	0.274	0.395	0.240	0.228	0.191	0.258	0.000	0.314	0.329	0.327	0.303	0.309	0.305
5	0.429	0.465	0.440	0.413	0.000	0.000	0.432	0.345	0.000	0.327	0.000	0.280	0.324	0.373	0.333	0.000	0.349	0.372	0.371	0.355	0.367	0.359
6	0.501	0.538	0.510	0.393	0.000	0.000	0.504	0.368	0.000	0.365	0.000	0.275	0.372	0.438	0.373	0.000	0.401	0.438	0.419	0.400	0.409	0.399
7	0.552	0.527	0.538	0.000	0.000	0.000	0.550	0.410	0.000	0.425	0.000	0.256	0.446	0.463	0.483	0.000	0.442	0.482	0.451	0.439	0.442	0.456
8	0.493	0.570	0.525	0.500	0.000	0.000	0.500	0.438	0.000	0.460	0.000	0.408	0.399	0.492	0.454	0.000	0.475	0.492	0.473	0.461	0.465	0.468
9	0.597	0.620	0.600	0.000	0.347	0.000	0.598	0.449	0.000	0.529	0.347	0.408	0.429	0.519	0.499	0.000	0.514	0.519	0.508	0.503	0.499	0.513
10	0.583	0.645	0.580	0.000	0.000	0.000	0.578	0.491	0.000	0.471	0.000	0.000	0.524	0.518	0.543	0.000	0.526	0.518	0.528	0.529	0.532	0.524
11	0.620	0.605	0.661	0.000	0.000	0.000	0.631	0.544	0.000	0.544	0.000	0.000	0.537	0.524	0.570	0.000	0.526	0.524	0.546	0.549	0.539	0.554
12	0.000	0.701	0.659	0.000	0.000	0.000	0.576	0.484	0.000	0.516	0.000	0.296	0.435	0.557	0.500	0.000	0.566	0.558	0.583	0.589	0.617	0.538
13	0.000	0.692	0.692	0.000	0.000	0.000	0.000	0.439	0.000	0.608	0.000	0.000	0.000	0.000	0.538	0.000	0.584	0.581	0.597	0.599	0.597	0.561
14	0.000	0.760	0.760	0.000	0.000	0.000	0.000	0.484	0.000	0.648	0.000	0.000	0.000	0.000	0.614	0.000	0.660	0.660	0.642	0.640	0.628	0.612
15+	0.000	0.799	0.799	0.000	0.000	0.000	0.000	0.559	0.000	0.656	0.000	0.322	0.666	0.000	0.654	0.000	0.695	0.661	0.669	0.744	0.616	0.657

Table 2.4.3.2 (continued) Mean Weight at age (kg) in the catch for NE Atlantic mackerel

Quarter 3

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.059	0.089	0.047	0.089	0.050	0.000	0.085	0.000	0.000	0.000	0.000	0.062	0.000	0.074	0.074
1	0.000	0.171	0.149	0.149	0.149	0.000	0.114	0.130	0.162	0.143	0.162	0.144	0.178	0.138	0.159	0.000	0.000	0.000	0.163	0.148	0.173	0.148
2	0.324	0.293	0.255	0.254	0.243	0.000	0.290	0.208	0.207	0.196	0.207	0.207	0.238	0.197	0.207	0.000	0.213	0.213	0.186	0.162	0.240	0.231
3	0.354	0.356	0.339	0.294	0.283	0.000	0.349	0.242	0.239	0.218	0.239	0.204	0.258	0.295	0.218	0.000	0.281	0.281	0.234	0.193	0.342	0.326
4	0.419	0.432	0.430	0.423	0.395	0.000	0.415	0.344	0.298	0.256	0.298	0.234	0.324	0.329	0.265	0.000	0.323	0.323	0.271	0.249	0.353	0.412
5	0.469	0.465	0.463	0.413	0.000	0.000	0.455	0.390	0.360	0.338	0.360	0.360	0.323	0.372	0.311	0.000	0.370	0.370	0.363	0.342	0.410	0.463
6	0.512	0.538	0.537	0.395	0.000	0.000	0.532	0.499	0.388	0.347	0.388	0.388	0.381	0.438	0.331	0.000	0.436	0.436	0.404	0.387	0.472	0.521
7	0.525	0.527	0.527	0.448	0.000	0.000	0.532	0.410	0.408	0.364	0.408	0.408	0.000	0.463	0.000	0.000	0.462	0.462	0.432	0.427	0.462	0.522
8	0.598	0.570	0.569	0.500	0.000	0.000	0.551	0.495	0.428	0.401	0.428	0.428	0.000	0.492	0.431	0.000	0.492	0.492	0.451	0.442	0.536	0.574
9	0.608	0.620	0.620	0.524	0.347	0.000	0.611	0.480	0.418	0.438	0.416	0.418	0.000	0.519	0.477	0.000	0.519	0.519	0.496	0.486	0.539	0.603
10	0.581	0.645	0.644	0.482	0.000	0.000	0.638	0.480	0.441	0.475	0.441	0.441	0.000	0.518	0.000	0.000	0.517	0.517	0.514	0.504	0.594	0.621
11	0.719	0.605	0.602	0.444	0.000	0.000	0.611	0.464	0.452	0.551	0.452	0.452	0.000	0.524	0.000	0.000	0.524	0.524	0.525	0.511	0.661	0.641
12	0.644	0.701	0.701	0.000	0.000	0.000	0.700	0.403	0.550	0.458	0.550	0.550	0.000	0.557	0.000	0.000	0.557	0.557	0.579	0.577	0.752	0.688
13	0.800	0.692	0.692	0.000	0.000	0.000	0.692	0.000	0.424	0.469	0.424	0.424	0.000	0.581	0.000	0.000	0.580	0.580	0.610	0.611	0.524	0.669
14	0.000	0.760	0.760	0.000	0.000	0.000	0.760	0.546	0.482	0.728	0.482	0.482	0.000	0.000	0.000	0.000	0.660	0.660	0.635	0.636	0.000	0.744
15+	0.804	0.799	0.799	0.000	0.000	0.000	0.799	0.441	0.446	0.339	0.446	0.446	0.000	0.000	0.530	0.000	0.660	0.660	0.633	0.636	0.833	0.776

Quarter 4

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0.000	0.000	0.061	0.000	0.000	0.000	0.000	0.061	0.112	0.000	0.000	0.112	0.000	0.098	0.000	0.000	0.118	0.118	0.075	0.109	0.078	0.078
1	0.000	0.186	0.185	0.152	0.167	0.185	0.185	0.183	0.162	0.162	0.151	0.162	0.178	0.138	0.178	0.000	0.162	0.162	0.165	0.167	0.179	0.156
2	0.309	0.337	0.305	0.284	0.243	0.285	0.285	0.254	0.223	0.251	0.263	0.224	0.238	0.196	0.238	0.000	0.194	0.194	0.184	0.189	0.225	0.245
3	0.352	0.373	0.343	0.348	0.249	0.321	0.321	0.271	0.229	0.274	0.299	0.229	0.258	0.208	0.258	0.000	0.261	0.261	0.231	0.231	0.325	0.299
4	0.427	0.440	0.421	0.430	0.296	0.406	0.406	0.332	0.271	0.328	0.352	0.274	0.324	0.261	0.324	0.000	0.391	0.391	0.282	0.277	0.345	0.386
5	0.473	0.483	0.464	0.451	0.310	0.460	0.460	0.379	0.355	0.366	0.455	0.363	0.323	0.000	0.323	0.000	0.451	0.451	0.369	0.348	0.415	0.455
6	0.496	0.537	0.484	0.481	0.508	0.472	0.472	0.451	0.294	0.421	0.518	0.299	0.381	0.289	0.381	0.000	0.452	0.452	0.429	0.408	0.481	0.474
7	0.527	0.483	0.481	0.528	0.000	0.489	0.489	0.472	0.428	0.501	0.000	0.428	0.000	0.000	0.000	0.000	0.452	0.452	0.463	0.432	0.468	0.481
8	0.577	0.575	0.583	0.560	0.000	0.588	0.588	0.420	0.259	0.000	0.000	0.259	0.000	0.241	0.000	0.000	0.452	0.452	0.488	0.451	0.542	0.536
9	0.608	0.627	0.601	0.587	0.000	0.573	0.573	0.575	0.418	0.455	0.000	0.418	0.000	0.000	0.000	0.000	0.452	0.452	0.522	0.488	0.543	0.595
10	0.640	0.648	0.641	0.730	0.000	0.599	0.599	0.572	0.424	0.512	0.000	0.424	0.000	0.000	0.000	0.000	0.452	0.452	0.553	0.498	0.597	0.607
11	0.643	0.605	0.596	0.596	0.000	0.596	0.596	0.344	0.000	0.558	0.000	0.000	0.000	0.000	0.000	0.000	0.452	0.452	0.572	0.502	0.745	0.593
12	0.725	0.695	0.682	0.676	0.406	0.699	0.699	0.507	0.426	0.000	0.000	0.426	0.000	0.000	0.000	0.000	0.000	0.000	0.590	0.532	0.809	0.668
13	0.800	0.602	0.584	0.649	0.000	0.649	0.649	0.573	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.610	0.596	0.000	0.586
14	0.000	0.725	0.707	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.634	0.635	0.000	0.708
15+	0.815	0.799	0.833	0.000	0.390	0.000	0.000	0.829	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.625	0.614	0.000	0.697

Quarter 1-4

Ages	IIa	IIIa	IVa	IVb	IVc	Va	Vb	VIa	VIIa	VIIbc	VIId	VIIef	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	IXa	All areas
0	0.000	0.000	0.061	0.000	0.000	0.000	0.000	0.060	0.097	0.047	0.089	0.065	0.000	0.088	0.000	0.000	0.118	0.118	0.074	0.109	0.076	0.076
1	0.056	0.182	0.161	0.149	0.154	0.185	0.130	0.152	0.161	0.151	0.159	0.157	0.178	0.136	0.167	0.000	0.115	0.079	0.157	0.131	0.090	0.143
2	0.324	0.261	0.279	0.256	0.243	0.285	0.287	0.245	0.188	0.227	0.211	0.215	0.237	0.178	0.198	0.189	0.190	0.194	0.188	0.162	0.209	0.228
3	0.354	0.331	0.325	0.308	0.275	0.321	0.342	0.259	0.205	0.245	0.243	0.216	0.254	0.218	0.234	0.254	0.284	0.288	0.293	0.223	0.297	0.284
4	0.419	0.400	0.385	0.425	0.311	0.406	0.401	0.328	0.246	0.302	0.304	0.253	0.292	0.288	0.294	0.326	0.315	0.319	0.324	0.292	0.312	0.358
5	0.468	0.458	0.431	0.433	0.310	0.460	0.446	0.396	0.293	0.360	0.391	0.329	0.334	0.359	0.357	0.389	0.354	0.359	0.368	0.346	0.378	0.414
6	0.511	0.518	0.469	0.452	0.508	0.472	0.523	0.426	0.286	0.404	0.412	0.293	0.367	0.409	0.390	0.450	0.410	0.422	0.417	0.393	0.435	0.454
7	0.526	0.529	0.487	0.526	0.000	0.489	0.537	0.466	0.271	0.466	0.402	0.287	0.437	0.419	0.473	0.508	0.447	0.455	0.450	0.433	0.441	0.481
8	0.593	0.585	0.531	0.506	0.000	0.588	0.532	0.536	0.348	0.504	0.428	0.268	0.444	0.475	0.482	0.527	0.474	0.486	0.473	0.454	0.468	0.524
9	0.607	0.609	0.568	0.586	0.347	0.573	0.604	0.548	0.411	0.530	0.414	0.413	0.472	0.513	0.531	0.631	0.504	0.517	0.510	0.497	0.500	0.553
10	0.583	0.645	0.602	0.724	0.000	0.599	0.627	0.581	0.428	0.537	0.441	0.424	0.525	0.516	0.525	0.450	0.515	0.521	0.528	0.522	0.548	0.578
11	0.715	0.630	0.576	0.584	0.000	0.596	0.617	0.651	0.452	0.593	0.452	0.452	0.537	0.524	0.568	0.562	0.516	0.525	0.545	0.540	0.544	0.592
12	0.646	0.700	0.670	0.676	0.406	0.699	0.699	0.627	0.311	0.551	0.536	0.318	0.435	0.513	0.500	0.000	0.564	0.561	0.582	0.585	0.627	0.640
13	0.800	0.667	0.599	0.649	0.000	0.649	0.692	0.606	0.424	0.611	0.424	0.424	0.000	0.581	0.538	0.000	0.584	0.582	0.596	0.599	0.595	0.600
14	0.000	0.693	0.707	0.000	0.000	0.000	0.760	0.566	0.482	0.747	0.482	0.482	0.000	0.000	0.614	0.000	0.660	0.660	0.644	0.639	0.628	0.636
15+	0.805	0.799	0.671	0.000	0.390	0.000	0.799	0.713	0.325	0.650	0.430	0.323	0.666	0.362	0.637	0.000	0.691	0.682	0.659	0.742	0.616	0.676

Table 2.4.3.3 Mean weight (kg) at age in the Stock for NE Atlantic mackerel based on the the Western Southern and North Sea components

	Western Stock		Southern Stock[1]		N. Sea Stock[2]		NE Atlantic Stock
Age	Weight (kg)	Relative weghting	Weight (kg)	Relative weghting	Weight (kg)	Relative weghting	Weight (kg)
1		0.825	0.161	0.150	0.138	0.026	0.840[3]
2	0.187	0.825	0.248	0.150	0.230	0.026	0.197
3	0.216	0.825	0.305	0.150	0.314	0.026	0.232
4	0.290	0.825	0.354	0.150	0.357	0.026	0.301
5	0.357	0.825	0.385	0.150	0.438	0.026	0.363
6	0.398	0.825	0.427	0.150	0.464	0.026	0.404
7	0.446	0.825	0.455	0.150	0.418	0.026	0.447
8	0.480	0.825	0.493	0.150	0.471	0.026	0.482
9	0.520	0.825	0.511	0.150	0.529	0.026	0.519
10	0.539	0.825	0.545	0.150	0.545	0.026	0.540
11	0.530	0.825	0.548	0.150	0.550	0.026	0.533
12	0.568	0.825	0.617	0.150	0.630	0.026	0.577
13	0.563	0.825	0.622	0.150	0.660	0.026	0.574
14	0.625	0.825	0.656	0.150	0.680	0.026	0.631
15+	0.603	0.825	0.716	0.150	0.690	0.026	0.623

[1] Constant values used since 1984
[2] Constant values used since 1984
[3] Constant values used since 1988

Table 2.4.4.1 Proportion mature at age for the North East Atlantic mackerel as obtained from the Western, Southern and North Sea components (weighting according spawing biomass of repective areas).

	Western Stock		Southern Stock		N. Sea Stock		NE Atlantic Stock Maturity ogive
Age	Maturity ogive	Weighting	Maturity ogive	Weighting	Maturity ogive	Weighting	Weighted mean
1	0.08	0.825	0.45	0.150	0.00	0.026	0.14
2	0.60	0.825	0.89	0.150	0.37	0.026	0.65
3	0.90	0.825	0.95	0.150	1.00	0.026	0.91
4	0.97	0.825	1.00	0.150	1.00	0.026	0.97
5	0.97	0.825	1.00	0.150	1.00	0.026	0.97
6	0.99	0.825	1.00	0.150	1.00	0.026	0.99
7	1.00	0.825	1.00	0.150	1.00	0.026	1.00
8	1.00	0.825	1.00	0.150	1.00	0.026	1.00
9	1.00	0.825	1.00	0.150	1.00	0.026	1.00
10	1.00	0.825	1.00	0.150	1.00	0.026	1.00
11	1.00	0.825	1.00	0.150	1.00	0.026	1.00
12	1.00	0.825	1.00	0.150	1.00	0.026	1.00
13	1.00	0.825	1.00	0.150	1.00	0.026	1.00
14	1.00	0.825	1.00	0.150	1.00	0.026	1.00
15+	1.00	0.825	1.00	0.150	1.00	0.026	1.00

Table 2.6.1.1 SOUTHERN MACKEREL. Effort data by fleets.

	SPAIN					PORTUGAL
	TRAWL		HOOCK (HAND-LINE)		PURSE SEINE	TRAWL
	AVILES (Subdiv.VIIIc East) (HP*fishing days*10^-2)	LA CORUÑA (Subdiv.VIIIc West) (Av. HP*fishing days*10^-2)	SANTANDER (Subdiv.VIIIc East) (Nº fishing trips)	SANTOÑA (Subdiv.VIIIc East) (Nº fishing trips)	VIGO (Subdiv.IXa North) (Nº fishing trips)	(Subdiv.IXa CN,CS &S) (Fishing hours)
YEAR	ANUAL	ANUAL	MARCH to MAY	MARCH to MAY	ANUAL	ANUAL
1983	12568	33999	-	-	20	-
1984	10815	32427	-	-	700	-
1985	9856	30255	-	-	215	-
1986	10845	26540	-	-	157	-
1987	8309	23122	-	-	92	-
1988	9047	28119	-	-	374	60601
1989	8063	29628	-	605	153	53428
1990	8492	29578	322	509	161	49532
1991	7677	26959	209	724	66	45467
1992	12693	26199	70	698	286	78272
1993	7635	29670	151	1216	-	48565
1994	9620	39590	130	1926	-	39062
1995	6146	41452	217	1696	-	44463
1996	4525	35728	560	2007	-	36002
1997	4699	35211	736	2095	-	31383

- Not available

Table 2.6.1.2 SOUTHERN MACKEREL. CPUE series in commercial fisheries.

	SPAIN					PORTUGAL
	TRAWL		HOOCK (HAND-LINE)		PURSE SEINE	TRAWL
	AVILES (Subdiv.VIIIc East) (Kg/HP*fishing days*10^-2)	LA CORUÑA (Subdiv.VIIIc West) (Kg/Av HP*fishing days*10^-2)	SANTANDER (Subdiv.VIIIc East) Kg/Nº fishing trips	SANTOÑA (Subdiv.VIIIc East) Kg/Nº fishing trips	VIGO (Subdiv.IXa North) (t/Nº fishing trips)	(Subdiv.IXa CN,CS &S) (Kg/Fishing hours)
YEAR	ANUAL	ANUAL	MARCH to MAY	MARCH to MAY	ANUAL	ANUAL
1983	14.2	34.2	-	-	1.3	-
1984	24.1	40.1	-	-	5.6	-
1985	17.6	38.1	-	-	4.2	-
1986	41.1	34.2	-	-	5.0	-
1987	13.0	36.5	-	-	2.1	-
1988	15.9	46.0	-	-	3.7	33.1
1989	19.0	43.0	-	1427.5	2.1	26.4
1990	82.7	59.0	739.6	1924.4	2.7	39.6
1991	68.2	54.6	632.9	1394.4	2.0	38.6
1992	35.1	19.7	905.6	856.4	3.9	20.3
1993	12.8	19.2	613.3	1790.9	-	16.6
1994	57.2	41.4	2388.5	1590.6	-	20.7
1995	94.9	34.0	3136.1	1987.9	-	24.6
1996	124.5	29.1	1165.7	1508.9	-	28.8
1997	133.2	35.7	2137.9	1867.8	-	24.8

- Not available

Table 2.6.1.3 SOUTHERN MACKEREL. CPUE at age from fleets.

VIIIc East handline fleet (Spain:Santoña) (Catch thousands)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1989	605	0	0	3	74	142	299	197	309	441	134	67	27	23	19	7	27
1990	509	0	0	0	17	71	210	465	177	384	378	127	40	51	2	7	5
1991	724	0	0	52	435	785	473	309	323	100	98	150	29	3	7	7	18
1992	698	0	0	35	568	442	477	139	69	77	20	15	17	4	4	0	1
1993	1216	0	0	40	65	1043	621	1487	771	345	339	215	126	59	66	30	52
1994	1926	0	23	168	526	1060	2005	1443	1003	406	360	176	98	54	24	24	9
1995	1696	0	41	83	793	1001	789	1092	998	928	519	339	300	159	83	81	63
1996	2007	0	0	28	401	1234	865	701	1361	802	773	330	288	105	13	28	18
1997	2095	0	7	255	709	3475	2591	894	880	693	471	248	146	98	24	11	11

VIIIc East handline fleet (Spain:Santander) (Catch thousands)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1990	322	0	0	0	6	25	66	132	41	86	83	28	8	11	0	2	2
1991	209	0	0	5	45	96	60	39	43	14	14	23	4	1	1	1	4
1992	70	0	0	4	60	47	51	15	7	8	2	2	2	0	0	0	0
1993	151	0	0	1	2	43	26	63	33	15	15	9	5	3	3	1	2
1994	130	0	2	18	56	110	205	146	101	40	36	18	10	5	2	2	1
1995	217	0	3	33	171	168	144	225	227	222	107	70	56	22	9	11	9
1996	560	0	0	6	89	276	191	152	293	171	164	70	60	22	3	6	4
1997	736	0	0	22	170	963	754	368	472	398	328	170	100	74	18	8	10

VIIIc East trawl fleet (Spain:Aviles) (Catch thousands)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1988	9047	0	333	25	78	126	28	34	31	15	6	1	0	1	2	0	1
1989	8063	0	535	201	66	38	53	17	23	29	7	3	2	2	2	0	4
1990	8492	1834	6690	145	123	147	158	181	21	24	17	6	1	1	3	5	24
1991	7677	95	2419	592	205	108	99	57	55	16	14	26	4	3	2	1	13
1992	12693	236	1495	329	122	65	115	56	38	52	16	19	27	13	4	0	2
1993	7635	3	31	48	8	49	20	37	20	11	13	7	6	9	5	3	9
1994	9620	0	83	317	299	180	302	204	144	56	45	21	12	7	3	4	1
1995	6146	0	9	139	261	168	125	177	156	147	74	50	44	20	10	11	9
1996	4525	0	327	126	274	527	149	81	134	70	63	27	21	8	1	2	3
1997	4699	368	786	934	183	391	167	48	49	43	37	22	14	13	3	2	5

VIIIc West trawl fleet (Spain:La Coruña) (Catch thousands)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1988	28119	0	6095	584	625	594	167	239	444	195	53	12	8	21	26	0	7
1989	29628	462	482	719	345	289	541	231	355	444	117	63	24	22	22	6	15
1990	29578	27	4535	939	175	235	370	624	184	409	405	145	45	69	5	9	5
1991	26959	1	39	454	573	839	551	445	504	165	165	266	53	4	10	11	23
1992	26199	1	154	102	298	251	355	128	61	84	25	32	38	14	6	0	2
1993	29670	0	307	440	118	523	188	265	98	41	33	21	11	3	4	2	3
1994	39590	0	237	1531	1085	821	1156	575	264	63	40	17	6	1	1	1	0
1995	41452	735	249	400	624	324	251	381	376	402	175	116	104	44	17	19	20
1996	35728	54	5865	104	562	695	148	77	127	55	59	27	20	8	1	2	2
1997	35211	13	626	1347	531	1234	493	136	140	114	88	49	32	25	6	3	6

IXa trawl fleet (Portugal) (Catch thousands)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1988	60601	8076	4510	536	457	76	14	3	0	1	5	0	0	0	0	0	0
1989	53428	6092	6468	1080	572	185	51	15	4	7	4	3	0	0	0	0	0
1990	49532	2840	5729	1957	137	36	11	4	4	0	0	0	0	0	0	0	0
1991	45467	1695	2397	1904	1090	138	85	65	24	3	5	0	0	0	0	0	0
1992	78272	498	2211	1015	664	263	100	45	22	17	10	70	0	0	0	0	0
1993	48565	1010	2365	442	172	155	32	8	5	1	0	1	0	0	0	0	0
1994	39062	650	1128	1447	342	125	94	65	21	4	1	2	0	1	0	0	0
1995	44463	1001	2690	983	295	99	59	46	40	25	17	16	8	5	0	0	1
1996	36002	423	1293	778	490	269	86	88	129	98	109	66	34	17	6	0	1
1997	31383	318	885	1763	181	98	125	95	59	47	20	20	6	10	0	0	0

Table 2.9.1.1 North East Atlantic mackerel. Catch numbers at age.

Mackerel NE Atlantic (run: ICAELT08/I08) Output Generated by ICA Version 1.4

Catch in Number

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	288.40	81.22	48.52	7.42	55.12	65.40	24.25	10.01	43.45	19.35	25.37	14.76	37.96	36.01
1	32.02	267.06	56.42	40.20	145.97	64.26	140.53	58.46	83.58	128.14	147.32	81.53	119.85	144.39
2	86.40	20.75	412.12	156.97	131.61	312.74	209.85	212.52	156.29	210.32	221.49	340.90	168.88	186.48
3	685.13	57.93	37.26	664.65	182.06	207.69	410.75	206.42	356.21	266.68	306.98	340.22	333.37	238.43
4	389.08	442.21	74.30	56.79	514.81	167.59	208.15	375.45	266.59	398.24	267.42	275.03	279.18	378.88
5	252.48	250.43	353.45	89.17	69.72	362.47	156.74	188.62	306.14	244.29	301.35	186.86	177.67	246.78
6	98.44	164.05	201.93	245.04	83.50	48.70	254.02	129.15	156.07	255.47	184.93	197.86	96.30	135.06
7	22.17	61.92	122.48	150.88	192.22	58.12	42.55	197.89	113.90	149.93	189.85	142.34	119.83	84.38
8	62.05	19.42	41.32	86.03	117.13	111.25	49.70	51.08	138.46	97.75	106.11	113.41	55.81	66.50
9	48.11	47.22	13.14	34.86	53.46	68.24	85.45	43.42	51.21	121.40	80.05	69.19	59.80	39.45
10	37.63	37.34	31.83	19.70	19.80	32.23	33.04	70.84	36.61	38.79	57.62	42.44	25.80	26.74
11	30.22	26.77	22.30	25.80	12.60	13.90	16.59	29.74	40.96	29.07	20.41	37.96	18.35	13.95
12	69.45	96.96	78.78	63.27	54.98	35.81	27.91	52.99	68.21	68.22	57.55	39.75	30.65	24.97

x 10 ^ 6

Table 2.9.1.2 North East Atlantic mackerel. Biomass estimates from egg surveys of which the 1998 estimate is preliminary.

INDICES OF SPAWNING BIOMASS

INDEX1

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	*******	*******	2470.0	*******	*******	2940.0	*******	*******	3370.0	*******	*******	2840.0	*******	*******	2414.0

x 10 ^ 3

Table 2.9.1.3 **North East Atlantic mackerel. Catch weights at age.**

Weights at age in the catches (Kg)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	.03100	.05500	.03900	.07600	.05500	.04900	.08500	.06800	.05100	.06100	.04600	.07200	.05800	.07600
1	.10200	.14400	.14600	.17900	.13300	.13600	.15600	.15600	.16700	.13400	.13600	.14300	.14300	.14300
2	.18400	.26200	.24500	.22300	.25900	.23700	.23300	.25300	.23900	.24000	.25500	.23400	.22600	.23000
3	.29500	.35700	.33500	.31800	.32300	.32000	.33600	.32700	.33300	.31700	.33900	.33300	.31300	.29500
4	.32600	.41800	.42300	.39900	.38800	.37700	.37900	.39400	.39700	.37600	.39000	.39000	.37700	.35900
5	.34400	.41700	.47100	.47400	.45600	.43300	.42300	.42300	.46000	.43600	.44800	.45200	.42500	.41500
6	.43100	.43600	.44400	.51200	.52400	.45600	.46700	.46900	.49500	.48300	.51200	.50100	.48400	.45300
7	.54200	.52100	.45700	.49300	.55500	.54300	.52800	.50600	.53200	.52700	.54300	.53900	.51800	.48100
8	.48000	.55500	.54300	.49800	.55500	.59200	.55200	.55400	.55500	.54800	.59000	.57700	.55100	.52400
9	.56900	.56400	.59100	.58000	.56200	.57800	.60600	.60900	.59700	.58300	.58300	.59400	.57600	.55300
10	.62800	.62900	.55200	.63400	.61300	.58100	.60600	.63000	.65100	.59500	.62700	.60600	.59600	.57700
11	.63600	.67900	.69400	.63500	.62400	.64800	.59100	.64900	.66300	.64700	.67800	.63100	.60300	.59100
12	.66300	.71000	.68800	.71800	.69700	.73900	.71300	.70800	.66900	.67900	.71300	.67200	.67000	.63600

Table 2.9.1.4 **North East Atlantic mackerel. Stock weights at age.**

Weights at age in the stock (Kg)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
1	.08700	.08700	.08700	.08600	.08400	.08400	.08400	.08400	.08400	.08400	.08400	.08400	.08400	.08400
2	.19800	.16800	.18000	.15800	.16100	.18700	.14600	.16400	.22100	.20100	.18600	.16600	.14100	.19700
3	.25700	.29500	.27000	.24600	.24400	.24800	.22700	.23900	.26400	.27000	.24100	.26600	.25300	.23200
4	.29700	.31100	.30200	.28400	.31000	.30700	.29100	.31400	.31600	.31800	.29900	.32200	.32000	.30100
5	.32100	.34000	.35300	.36800	.33600	.34800	.33900	.36000	.36300	.36100	.35800	.39100	.36000	.36300
6	.38900	.37800	.35400	.38200	.43300	.37300	.37400	.41100	.40400	.41800	.41000	.44200	.44000	.40400
7	.43500	.42900	.40700	.40400	.45500	.42400	.41200	.43500	.42900	.45800	.46600	.48700	.46300	.44700
8	.43500	.45100	.47300	.41900	.44500	.47200	.40800	.50400	.46800	.46800	.46800	.50400	.50300	.48200
9	.47400	.46000	.45500	.47000	.46800	.45200	.43400	.54200	.49200	.48500	.47800	.54100	.56600	.51900
10	.52100	.55400	.46900	.49500	.53100	.46500	.51900	.57000	.52600	.51700	.54900	.50800	.57500	.54000
11	.50800	.57500	.48800	.46200	.59700	.50400	.51900	.57000	.55500	.59000	.60200	.61500	.61300	.53300
12	.57300	.61100	.58600	.56900	.64700	.59700	.53700	.58600	.59200	.57400	.57900	.63500	.63800	.60100

Table 2.9.1.5 North East Atlantic mackerel. Natural mortality.

Natural Mortality (per year)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000
1	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000
2	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000
3	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000
4	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000
5	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000
6	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000
7	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000
8	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000
9	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000
10	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000
11	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000
12	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000	.15000

Table 2.9.1.6 North East Atlantic mackerel. Proportion of fish spawning.

Proportion of fish spawning

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.1400	.1400	.1400	.1400	.1400	.1400	.1400	.1400	.1400	.1400	.1400	.1400	.1400	.1400
2	.6500	.6500	.6500	.6500	.6500	.6500	.6500	.6500	.6500	.6500	.6500	.6500	.6500	.6500
3	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100
4	.9700	.9700	.9700	.9700	.9700	.9700	.9700	.9700	.9700	.9700	.9700	.9700	.9700	.9700
5	.9700	.9700	.9700	.9700	.9700	.9700	.9700	.9700	.9700	.9700	.9700	.9700	.9700	.9700
6	.9900	.9900	.9900	.9900	.9900	.9900	.9900	.9900	.9900	.9900	.9900	.9900	.9900	.9900
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.9.1.7a **North East Atlantic mackerel. Diagnostic output.**

Predicted Catch in Number

AGE	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	19.45	37.80	26.97	22.91	14.77	18.51	25.14	40.51	24.24	32.21	37.81	36.17
1	51.92	60.36	105.64	70.06	96.38	65.13	87.40	131.08	162.20	95.43	104.15	144.45
2	284.76	166.82	174.10	229.14	159.22	229.00	164.96	241.97	277.60	337.89	164.39	213.01
3	70.68	356.53	186.52	190.54	329.62	238.69	363.55	282.42	314.16	354.77	360.09	209.84
4	87.21	76.25	342.57	196.86	198.10	356.16	271.50	440.57	256.77	281.29	266.62	327.46
5	238.14	107.46	83.43	347.32	171.65	179.18	337.75	272.06	328.44	188.56	174.10	201.24
6	158.07	255.17	101.72	59.53	259.12	132.78	145.14	288.39	171.92	204.45	98.96	111.91
7	105.37	164.72	233.68	62.87	49.38	222.66	119.26	136.91	201.34	118.27	118.95	70.56
8	45.17	85.16	116.40	111.63	46.77	38.03	178.98	100.37	84.88	123.00	61.16	75.69
9	18.42	28.66	47.31	64.50	95.94	41.53	35.12	171.77	70.89	59.10	72.93	44.71
10	32.80	16.25	22.24	31.65	40.82	62.75	28.25	24.82	88.53	36.01	25.49	39.05
11	22.25	24.96	10.88	13.74	22.30	29.75	47.65	22.37	14.42	50.68	17.48	15.29

x 10 ^ 6

Weighting factors for the catches in number

AGE	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.9.1.7b North East Atlantic mackerel. Diagnostic output.

Predicted SSB Index Values

INDEX1

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	*******	*******	2696.6	*******	*******	2783.5	*******	*******	2958.2	*******	*******	2366.3	*******	*******	2409.3

x 10 ^ 3

Fitted Selection Pattern

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	.1777	.1300	.0451	.0451	.0451	.0292	.0292	.0292	.0292	.0292	.0292	.0292	.0292	.0292
1	.1091	.2490	.1395	.1395	.1395	.1394	.1394	.1394	.1394	.1394	.1394	.1394	.1394	.1394
2	.2637	.1046	.4613	.4613	.4613	.3704	.3704	.3704	.3704	.3704	.3704	.3704	.3704	.3704
3	.8404	.2712	.6162	.6162	.6162	.6521	.6521	.6521	.6521	.6521	.6521	.6521	.6521	.6521
4	.8732	.9571	.7237	.7237	.7237	.8679	.8679	.8679	.8679	.8679	.8679	.8679	.8679	.8679
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	.9496	1.1977	1.2510	1.2510	1.2510	.9978	.9978	.9978	.9978	.9978	.9978	.9978	.9978	.9978
7	.4794	1.0819	1.5929	1.5929	1.5929	1.1185	1.1185	1.1185	1.1185	1.1185	1.1185	1.1185	1.1185	1.1185
8	.7261	.6893	1.6166	1.6166	1.6166	1.1393	1.1393	1.1393	1.1393	1.1393	1.1393	1.1393	1.1393	1.1393
9	.7479	.9609	1.2543	1.2543	1.2543	1.3703	1.3703	1.3703	1.3703	1.3703	1.3703	1.3703	1.3703	1.3703
10	.8008	1.0176	1.3239	1.3239	1.3239	1.2248	1.2248	1.2248	1.2248	1.2248	1.2248	1.2248	1.2248	1.2248
11	.9162	1.0047	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
12	.9162	1.0047	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000

Table 2.9.1.7c **North East Atlantic mackerel. Diagnostic output.**

IFAP run code: I08

No of years for separable analysis : 12
Age range in the analysis : 0 . . . 12
Year range in the analysis : 1984 . . . 1997
Number of indices of SSB : 1
Number of age-structured indices : 0

Parameters to estimate : 55
Number of observations : 149

Two selection vectors to be fitted.
Selection assumed constant up to and including : 1988
Abrupt change in selection specified.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1986	.1415	14	.1057	.1894	.1219	.1642	.1430
2	1987	.1675	14	.1271	.2207	.1455	.1928	.1691
3	1988	.1787	13	.1373	.2327	.1562	.2045	.1804
4	1989	.1774	11	.1425	.2208	.1587	.1983	.1785
5	1990	.1846	11	.1486	.2293	.1652	.2062	.1857
6	1991	.2015	10	.1625	.2500	.1806	.2249	.2028
7	1992	.2363	11	.1902	.2936	.2115	.2640	.2377
8	1993	.3074	11	.2453	.3853	.2740	.3450	.3095
9	1994	.3076	12	.2404	.3935	.2712	.3488	.3100
10	1995	.3024	14	.2279	.4013	.2617	.3494	.3056
11	1996	.2432	16	.1746	.3388	.2053	.2880	.2467
12	1997	.2307	19	.1577	.3375	.1900	.2802	.2351

Table 2.9.1.7d North East Atlantic mackerel. Diagnostic output.

Separable Model: Selection (S1) by age 1986 1988

13	0	.0451	133	.0033	.6171	.0119	.1714	.1099
14	1	.1395	18	.0964	.2019	.1155	.1684	.1420
15	2	.4613	18	.3204	.6641	.3830	.5556	.4694
16	3	.6162	18	.4286	.8861	.5120	.7417	.6269
17	4	.7237	18	.5036	1.0400	.6014	.8707	.7362
	5	1.0000		Fixed : Reference Age				
18	6	1.2510	18	.8730	1.7929	1.0412	1.5032	1.2723
19	7	1.5929	18	1.1139	2.2779	1.3272	1.9118	1.6196
20	8	1.6166	18	1.1297	2.3134	1.3465	1.9410	1.6439
21	9	1.2543	18	.8795	1.7887	1.0465	1.5032	1.2750
22	10	1.3239	17	.9327	1.8793	1.1073	1.5830	1.3453
	11	1.2000		Fixed : Last true age				

Separable Model: Selection (S2) by age from 1989 to 1997

23	0	.0292	81	.0059	.1448	.0129	.0661	.0408
24	1	.1394	12	.1088	.1786	.1229	.1582	.1405
25	2	.3704	11	.2933	.4677	.3288	.4172	.3730
26	3	.6521	11	.5215	.8154	.5818	.7308	.6563
27	4	.8679	11	.6991	1.0776	.7772	.9692	.8733
	5	1.0000		Fixed : Reference Age				
28	6	.9978	10	.8136	1.2237	.8992	1.1073	1.0032
29	7	1.1185	10	.9184	1.3622	1.0115	1.2369	1.1242
30	8	1.1393	9	.9422	1.3776	1.0341	1.2552	1.1447
31	9	1.3703	9	1.1409	1.6457	1.2480	1.5045	1.3763
32	10	1.2248	9	1.0134	1.4803	1.1120	1.3491	1.2306
	11	1.2000		Fixed : Last true age				

Table 2.9.1.7e **North East Atlantic mackerel. Diagnostic output.**

Separable model: Populations in year 1997

33	0	5795059	239	52943	634311351	527991	63604642	102171089
34	1	4912273	29	2771654	8706146	3668382	6577947	5126200
35	2	2797806	23	1766773	4430517	2212901	3537310	2875820
36	3	1614830	20	1078309	2418301	1314151	1984304	1649472
37	4	1938312	18	1347964	2787208	1610428	2332954	1971883
38	5	1048763	17	737512	1491369	876321	1255138	1065821
39	6	584341	17	411112	830563	488376	699162	593820
40	7	332971	17	234606	472578	278497	398099	338327
41	8	351477	17	247230	499681	293724	420585	357185
42	9	176941	18	123522	253463	147297	212552	179941
43	10	170219	19	116225	249296	140108	206801	173475
44	11	67827	20	45242	101688	55167	83393	69290

Separable model: Populations at age

45	1986	153136	26	90571	258920	117140	200193	158734
46	1987	147258	21	96591	224502	118751	182607	150706
47	1988	60506	18	41732	87724	50060	73131	61602
48	1989	76991	17	54742	108282	64695	91624	78165
49	1990	120533	15	88503	164154	102959	141107	122039
50	1991	148700	14	110859	199459	128009	172736	150379
51	1992	207097	14	156778	273566	179678	238699	209196
52	1993	77731	13	59137	102171	67611	89366	78491
53	1994	50080	14	37583	66732	43257	57979	50620
54	1995	178514	16	129910	245302	151792	209940	180877
55	1996	74109	18	51722	106186	61685	89036	75368

SSB Index catchabilities

INDEX1

Absolute estimator. No fitted catchability.

Table 2.9.1.7f **North East Atlantic mackerel. Diagnostic output.**

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	.914	-1.629	.715	1.049	.496	-.615	.547	-.739	.045	-.781	.004	-.004
1	.083	-.406	.323	-.086	.377	-.108	-.045	-.023	-.096	-.157	.140	.000
2	.370	-.061	-.280	.311	.276	-.075	-.054	-.140	-.226	.009	.027	-.133
3	-.640	.623	-.024	.086	.220	-.145	-.020	-.057	-.023	-.042	-.077	.128
4	-.160	-.295	.407	-.161	.049	.053	-.018	-.101	.041	-.022	.046	.146
5	.395	-.187	-.180	.043	-.091	.051	-.098	-.108	-.086	-.009	.020	.204
6	.245	-.041	-.197	-.201	-.020	-.028	.073	-.121	.073	-.033	-.027	.188
7	.150	-.088	-.195	-.079	-.149	-.118	-.046	.091	-.059	.185	.007	.179
8	-.089	.010	.006	-.003	.061	.295	-.257	-.027	.223	-.081	-.091	-.129
9	-.338	.196	.122	.056	-.116	.044	.377	-.347	.122	.158	-.199	-.125
10	-.030	.192	-.116	.018	-.211	.121	.259	.446	-.429	.164	.012	-.379
11	.002	.033	.147	.012	-.296	.000	-.151	.262	.347	-.289	.049	-.091

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	*******	*******	-.0878	*******	*******	.0547	*******	*******	.1303	*******	*******	.1825	*******	*******	.0020

Table 2.9.1.7g **North East Atlantic mackerel. Diagnostic output.**

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1986 to 1997

Variance	.0556
Skewness test stat.	.7461
Kurtosis test statistic	2.8891
Partial chi-square	.4370
Significance in fit	.0000
Degrees of freedom	99

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1

Index used as absolute measure of abundance

Variance	.0122
Skewness test stat.	1.0541
Kurtosis test statistic	-.4700
Partial chi-square	.0041
Significance in fit	.0000
Number of observations	5
Degrees of freedom	5
Weight in the analysis	1.0000

Table 2.9.1.7h **North East Atlantic mackerel. Diagnostic output.**

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	12.1148	149	55	94	.1289
Catches at age	12.0538	144	55	89	.1354
SSB Indices					
INDEX1	.0610	5	0	5	.0122

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	5.0076	149	55	94	.0533
Catches at age	4.9466	144	55	89	.0556
SSB Indices					
INDEX1	.0610	5	0	5	.0122

Table 2.9.1.8 North East Atlantic mackerel. Fishing mortality at age.

Fishing Mortality (per year)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	.04412	.02597	.00638	.00756	.00806	.00518	.00540	.00589	.00691	.00899	.00899	.00884	.00711	.00674
1	.02709	.04975	.01973	.02336	.02493	.02473	.02574	.02810	.03294	.04286	.04288	.04216	.03391	.03217
2	.06549	.02089	.06526	.07726	.08245	.06570	.06837	.07464	.08751	.11387	.11391	.11200	.09007	.08545
3	.20866	.05417	.08718	.10320	.11014	.11567	.12037	.13141	.15408	.20048	.20056	.19719	.15858	.15045
4	.21680	.19120	.10238	.12119	.12934	.15397	.16022	.17492	.20509	.26685	.26696	.26247	.21108	.20025
5	.24829	.19977	.14147	.16747	.17873	.17739	.18460	.20153	.23629	.30745	.30757	.30240	.24320	.23072
6	.23579	.23926	.17698	.20951	.22360	.17701	.18420	.20109	.23577	.30678	.30690	.30174	.24267	.23022
7	.11903	.21614	.22535	.26676	.28469	.19842	.20648	.22542	.26429	.34389	.34403	.33824	.27202	.25806
8	.18029	.13770	.22870	.27073	.28893	.20210	.21031	.22960	.26920	.35027	.35041	.34452	.27707	.26286
9	.18569	.19196	.17744	.21005	.22417	.24307	.25295	.27615	.32378	.42128	.42145	.41437	.33324	.31614
10	.19882	.20330	.18730	.22172	.23663	.21727	.22610	.24684	.28941	.37657	.37672	.37039	.29787	.28259
11	.22747	.20070	.16976	.20096	.21447	.21287	.22152	.24184	.28355	.36894	.36909	.36288	.29184	.27686
12	.22747	.20070	.16976	.20096	.21447	.21287	.22152	.24184	.28355	.36894	.36909	.36288	.29184	.27686

Table 2.9.1.9 North East Atlantic mackerel. Population numbers at age.

Population Abundance (1 January)

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	7190.8	3410.9	3290.9	5406.9	3616.1	4769.4	2955.9	3392.8	3933.6	4875.7	2916.7	3941.6	5748.0	5795.1	3665.4
1	1289.7	5922.1	2860.5	2814.5	4618.7	3087.4	4083.8	2530.5	2903.1	3362.4	4159.0	2488.0	3362.7	4912.3	4954.3
2	1466.5	1080.4	4849.8	2414.0	2366.5	3877.5	2592.5	3425.7	2117.7	2417.7	2772.6	3429.4	2053.0	2797.8	4094.2
3	3907.4	1182.3	910.7	3910.5	1923.2	1875.7	3125.2	2083.9	2736.4	1670.0	1857.0	2129.5	2639.0	1614.8	2210.9
4	2143.9	2729.7	963.9	718.4	3035.8	1482.7	1438.1	2384.8	1572.7	2019.0	1176.2	1307.9	1504.9	1938.3	1195.8
5	1232.8	1485.6	1940.6	748.9	547.7	2295.9	1094.1	1054.5	1723.2	1102.7	1330.7	775.2	865.8	1048.8	1365.6
6	503.2	827.8	1047.1	1450.0	545.2	394.3	1654.9	782.9	742.0	1171.1	697.9	842.1	493.1	584.3	716.7
7	212.4	342.1	560.9	755.1	1012.1	375.2	284.3	1184.8	551.1	504.5	741.7	441.9	536.0	333.0	399.5
8	404.1	162.3	237.2	385.3	497.7	655.3	264.8	199.1	813.9	364.2	307.9	452.5	271.2	351.5	221.4
9	305.0	290.5	121.7	162.5	253.0	320.9	460.8	184.7	136.2	535.2	220.8	186.6	276.0	176.9	232.6
10	224.2	218.0	206.3	87.7	113.3	174.0	216.6	308.0	120.6	84.8	302.3	124.7	106.2	170.2	111.0
11	159.5	158.2	153.1	147.3	60.5	77.0	120.5	148.7	207.1	77.7	50.1	178.5	74.1	67.8	110.4
12	366.5	572.8	542.2	373.3	305.9	200.6	150.8	264.8	296.4	237.0	199.9	140.0	129.9	110.8	116.6

x 10 ^ 6

Table 2.9.1.10 **North East Atlantic mackerel. Stock summary.**

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 4- 8	SoP (%)
1984	7190830	3455593	2721491	648084	.2381	.2000	100
1985	3410870	3627702	2675376	614275	.2296	.1968	100
1986	3290920	3599605	2696616	602128	.2233	.1750	103
1987	5406900	3485670	2678887	654805	.2444	.2071	99
1988	3616110	3694056	2763900	676288	.2447	.2211	103
1989	4769370	3703779	2783471	585921	.2105	.1818	100
1990	2955920	3520398	2644706	625611	.2366	.1892	99
1991	3392800	3853973	2970131	667883	.2249	.2065	98
1992	3933640	3894795	2958234	760351	.2570	.2421	99
1993	4875700	3635709	2648877	825036	.3115	.3150	100
1994	2916690	3333918	2348923	822570	.3502	.3152	100
1995	3941570	3247501	2366277	756186	.3196	.3099	99
1996	5747960	2979984	2202836	563585	.2558	.2492	100
1997	5795060	3143408	2202088	569543	.2586	.2364	99

Table 2.10.1 North East Atlantic mackerel. Multifleet prediction: Input data.

1998	Northern		Southern							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0013	0.069	0.0048	0.069	3872.000	0.1500	0.0000	0.4000	0.4000	0.000
1	0.0248	0.143	0.0045	0.143	3299.300	0.1500	0.1400	0.4000	0.4000	0.084
2	0.0773	0.230	0.0037	0.230	2716.700	0.1500	0.6500	0.4000	0.4000	0.168
3	0.1339	0.314	0.0037	0.314	3012.500	0.1500	0.9100	0.4000	0.4000	0.250
4	0.1727	0.375	0.0083	0.375	1238.600	0.1500	0.9700	0.4000	0.4000	0.314
5	0.1964	0.431	0.0085	0.431	1429.300	0.1500	0.9700	0.4000	0.4000	0.371
6	0.1923	0.479	0.0078	0.479	744.500	0.1500	0.9900	0.4000	0.4000	0.429
7	0.2081	0.513	0.0134	0.513	435.900	0.1500	1.0000	0.4000	0.4000	0.466
8	0.2169	0.551	0.0167	0.551	251.400	0.1500	1.0000	0.4000	0.4000	0.496
9	0.2589	0.574	0.0220	0.574	313.600	0.1500	1.0000	0.4000	0.4000	0.542
10	0.2404	0.593	0.0206	0.593	154.500	0.1500	1.0000	0.4000	0.4000	0.541
11	0.2271	0.608	0.0188	0.608	167.100	0.1500	1.0000	0.4000	0.4000	0.587
12+	0.2293	0.659	0.0167	0.659	228.200	0.1500	1.0000	0.4000	0.4000	0.625
Unit	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Kilograms

1999	Northern		Southern							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0013	0.069	0.0048	0.069	3872.000	0.1500	0.0000	0.4000	0.4000	0.000
1	0.0248	0.143	0.0045	0.143	.	0.1500	0.1400	0.4000	0.4000	0.084
2	0.0773	0.230	0.0037	0.230	.	0.1500	0.6500	0.4000	0.4000	0.168
3	0.1339	0.314	0.0037	0.314	.	0.1500	0.9100	0.4000	0.4000	0.250
4	0.1727	0.375	0.0083	0.375	.	0.1500	0.9700	0.4000	0.4000	0.314
5	0.1964	0.431	0.0085	0.431	.	0.1500	0.9700	0.4000	0.4000	0.371
6	0.1923	0.479	0.0078	0.479	.	0.1500	0.9900	0.4000	0.4000	0.429
7	0.2081	0.513	0.0134	0.513	.	0.1500	1.0000	0.4000	0.4000	0.466
8	0.2169	0.551	0.0167	0.551	.	0.1500	1.0000	0.4000	0.4000	0.496
9	0.2589	0.574	0.0220	0.574	.	0.1500	1.0000	0.4000	0.4000	0.542
10	0.2404	0.593	0.0206	0.593	.	0.1500	1.0000	0.4000	0.4000	0.541
11	0.2271	0.608	0.0188	0.608	.	0.1500	1.0000	0.4000	0.4000	0.587
12+	0.2293	0.659	0.0167	0.659	.	0.1500	1.0000	0.4000	0.4000	0.625
Unit	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Kilograms

2000	Northern		Southern							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock
0	0.0013	0.069	0.0048	0.069	.	0.1500	0.0000	0.4000	0.4000	0.000
1	0.0248	0.143	0.0045	0.143	.	0.1500	0.1400	0.4000	0.4000	0.084
2	0.0773	0.230	0.0037	0.230	.	0.1500	0.6500	0.4000	0.4000	0.168
3	0.1339	0.314	0.0037	0.314	.	0.1500	0.9100	0.4000	0.4000	0.250
4	0.1727	0.375	0.0083	0.375	.	0.1500	0.9700	0.4000	0.4000	0.314
5	0.1964	0.431	0.0085	0.431	.	0.1500	0.9700	0.4000	0.4000	0.371
6	0.1923	0.479	0.0078	0.479	.	0.1500	0.9900	0.4000	0.4000	0.429
7	0.2081	0.513	0.0134	0.513	.	0.1500	1.0000	0.4000	0.4000	0.466
8	0.2169	0.551	0.0167	0.551	.	0.1500	1.0000	0.4000	0.4000	0.496
9	0.2589	0.574	0.0220	0.574	.	0.1500	1.0000	0.4000	0.4000	0.542
10	0.2404	0.593	0.0206	0.593	.	0.1500	1.0000	0.4000	0.4000	0.541
11	0.2271	0.608	0.0188	0.608	.	0.1500	1.0000	0.4000	0.4000	0.587
12+	0.2293	0.659	0.0167	0.659	.	0.1500	1.0000	0.4000	0.4000	0.625
Unit	-	Kilograms	-	Kilograms	Millions	-	-	-	-	Kilograms

Notes: Run name : SPRELT01
Date and time: 030CT98:14:28

Table 2.10.2a North East Atlantic mackerel. Multifleet prediction summary table. Status quo F constraint of 0.22 for each fleet in 1998 and F = 0.15 in 1999 and 2000.

14:26 Saturday, October 3, 1998

	Northern				Southern				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.0567	0.2085	1524119	588260	1.0567	0.0116	100724	32714	1624844	620974	17863600	3547345	9844750	3050711	8672327	2659564
1999	0.7200	0.1420	1062449	413636	0.7200	0.0079	71108	23244	1133557	436880	17744604	3545296	9764558	3060740	8782236	2734261
2000	0.7200	0.1420	.	.	0.7200	0.0079	.	.	1168267	461862	14223832	3702641	10084879	3211144	9063341	2866187
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRELT01
Date and time : 030CT98:17:40
Computation of ref. F: Northern: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
Prediction basis : F factors

Table 2.10.2b North East Atlantic mackerel. Multifleet prediction summary table. Status quo F constraint of 0.22 for each fleet in 1998 and F = 0.175 in 1999 and 2000.

14:26 Saturday, October 3, 1998

	Northern				Southern				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.0567	0.2085	1524119	588260	1.0567	0.0116	100724	32714	1624844	620974	17863600	3547345	9844750	3050711	8672327	2659564
1999	0.8400	0.1657	1227638	477441	0.8400	0.0092	82328	26835	1309966	504275	17744604	3545296	9764558	3060740	8715376	2710369
2000	0.8400	0.1657	.	.	0.8400	0.0092	.	.	1327171	522650	14060868	3640632	9931449	3151105	8857962	2788027
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRELT01
Date and time : 030CT98:17:40
Computation of ref. F: Northern: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
Prediction basis : F factors

Table 2.10.2c North East Atlantic mackerel. Multifleet prediction summary table. Status quo F constraint of 0.22 for each fleet in 1998 and F = 0.20 in 1999 and 2000.

	Northern				Southern				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.0567	0.2085	1524119	588260	1.0567	0.0116	100724	32714	1624844	620974	17863600	3547345	9844750	3050711	8672327	2659564
1999	0.9610	0.1896	1390968	540384	0.9610	0.0105	93471	30378	1484439	570762	17744604	3545296	9764558	3060740	8648547	2686506
2000	0.9610	0.1896	.	.	0.9610	0.0105	.	.	1478420	579924	13899777	3579480	9779898	3091917	8656816	2711695
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRELT01
Date and time : 030CT98:17:52
Computation of ref. F: Northern: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
Prediction basis : F factors

Table 2.10.2d North East Atlantic mackerel. Multifleet prediction summary table. Status quo F constraint of 0.22 for each fleet in 1998 and F = 0.2325 in 1999 and 2000.

	Northern				Southern				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.0567	0.2085	1524119	588260	1.0567	0.0116	100724	32714	1624844	620974	17863600	3547345	9844750	3050711	8672327	2659564
1999	1.1170	0.2204	1596864	619525	1.1170	0.0122	107590	34836	1704454	654361	17744604	3545296	9764558	3060740	8563250	2656076
2000	1.1170	0.2204	.	.	1.1170	0.0122	.	.	1660857	648165	13696761	3502622	9589074	3017559	8405988	2616824
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRELT01
Date and time : 030CT98:18:10
Computation of ref. F: Northern: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
Prediction basis : F factors

Table 2.10.3a North East Atlantic mackerel. Multifleet prediction summary table. Catch constraint of 650 kt in 1998 and F = 0.15 in 1999 and 2000.

	Northern				Southern				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.1130	0.2196	1598239	616546	1.1130	0.0122	105720	34288	1703959	650835	17863600	3547345	9844750	3050711	8641665	2648682
1999	0.7202	0.1421	1054547	410009	0.7202	0.0079	70687	23038	1125234	433047	17671614	3517813	9695916	3034138	8721003	2710616
2000	0.7202	0.1421	.	.	0.7202	0.0079	.	.	1161429	458498	14168710	3679402	10031127	3188294	9015574	2845933
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRELT01
Date and time : 04OCT98:11:19
Computation of ref. F: Northern: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
Prediction basis : F factors

Table 2.10.3b North East Atlantic mackerel. Multifleet prediction summary table. Catch constraint of 650 kt in 1998 and F = 0.175 in 1999 and 2000.

	Northern				Southern				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.1130	0.2196	1598239	616546	1.1130	0.0122	105720	34288	1703959	650835	17863600	3547345	9844750	3050711	8641665	2648682
1999	0.8404	0.1658	1218746	473345	0.8404	0.0092	81859	26602	1300605	499947	17671614	3517813	9695916	3034138	8654601	2686917
2000	0.8404	0.1658	.	.	0.8404	0.0092	.	.	1319679	518945	14006704	3617841	9878653	3128699	8811397	2768330
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRELT01
Date and time : 04OCT98:11:19
Computation of ref. F: Northern: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
Prediction basis : F factors

Table 2.10.3c North East Atlantic mackerel. Multifleet prediction summary table. Catch constraint of 650 kt in 1998 and F = 0.20 in 1999 and 2000.

	Northern				Southern				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.1130	0.2196	1598239	616546	1.1130	0.0122	105720	34288	1703959	650835	17863600	3547345	9844750	3050711	8641665	2648682
1999	0.9606	0.1895	1379769	535315	0.9606	0.0105	92862	30091	1472631	565406	17671614	3517813	9695916	3034138	8588776	2663442
2000	0.9606	0.1895	.	.	0.9606	0.0105	.	.	1469101	575444	13847871	3557627	9729279	3070430	8613058	2693162
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRELT01
Date and time : 04OCT98:11:19
Computation of ref. F: Northern: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
Prediction basis : F factors

10:22 Sunday, October 4, 1998

Table 2.10.3d North East Atlantic mackerel. Multifleet prediction summary table. Catch constraint of 650 kt in 1998 and F = 0.2325 in 1999 and 2000.

	Northern				Southern				Total				1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	F Factor	Reference F	Catch in numbers	Catch in weight	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.1130	0.2196	1598239	616546	1.1130	0.0122	105720	34288	1703959	650835	17863600	3547345	9844750	3050711	8641665	2648682
1999	1.1168	0.2203	1584386	613856	1.1168	0.0122	106917	34515	1691303	648372	17671614	3517813	9695916	3034138	8504091	2633269
2000	1.1169	0.2203	.	.	1.1168	0.0122	.	.	1650952	643366	13646092	3481340	9539686	2996639	8363687	2598964
Unit	-	-	Thousands	Tonnes	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRELT01
Date and time : 04OCT98:11:19
Computation of ref. F: Northern: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
Prediction basis : F factors

Table 2.10.4 North East Atlantic mackerel. Multifleet management option table assuming a status quo fishing mortality of 0.22 for each fleet in 1998.

Year: 1998								
Northern			Southern			Total		
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
1.0567	0.2085	588260	1.0567	0.0116	32714	620974	3547345	2659564
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 1999									Year: 2000	
Northern			Southern			Total				
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass	Stock biomass	Sp.stock biomass
0.0000	0.0000	0	0.0000	0.0000	0	0	3545296	2882496	4105105	3391598
0.1000	0.0197	60767	0.1000	0.0011	3412	64179	.	2861397	4045931	3312417
0.2000	0.0395	120426	0.2000	0.0022	6763	127189	.	2840466	3987851	3235338
0.3000	0.0592	179000	0.3000	0.0033	10053	189054	.	2819700	3930843	3160302
0.4000	0.0789	236510	0.4000	0.0044	13285	249795	.	2799098	3874885	3087252
0.5000	0.0986	292978	0.5000	0.0055	16459	309436	.	2778660	3819958	3016130
0.6000	0.1184	348423	0.6000	0.0066	19576	367999	.	2758382	3766039	2946883
0.7000	0.1381	402866	0.7000	0.0077	22638	425504	.	2738266	3713110	2879458
0.8000	0.1578	456327	0.8000	0.0088	25646	481973	.	2718308	3661149	2813804
0.9000	0.1776	508825	0.9000	0.0098	28601	537426	.	2698507	3610139	2749870
1.0000	0.1973	560379	1.0000	0.0109	31504	591884	.	2678863	3560059	2687609
1.1000	0.2170	611009	1.1000	0.0120	34356	645365	.	2659374	3510891	2626974
1.2000	0.2367	660731	1.2000	0.0131	37159	697890	.	2640038	3462618	2567919
1.3000	0.2565	709564	1.3000	0.0142	39912	749476	.	2620855	3415221	2510399
1.4000	0.2762	757526	1.4000	0.0153	42618	800144	.	2601823	3368683	2454373
1.5000	0.2959	804633	1.5000	0.0164	45277	849910	.	2582941	3322986	2399798
1.6000	0.3156	850902	1.6000	0.0175	47890	898792	.	2564208	3278115	2346634
1.7000	0.3354	896349	1.7000	0.0186	50458	946808	.	2545622	3234053	2294841
1.8000	0.3551	940992	1.8000	0.0197	52982	993974	.	2527182	3190784	2244382
1.9000	0.3748	984844	1.9000	0.0208	55464	1040308	.	2508887	3148292	2195220
2.0000	0.3946	1027923	2.0000	0.0219	57903	1085826	.	2490736	3106561	2147318
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANELT01
Date and time : 040CT98:10:24
Computation of ref. F: Northern: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
Basis for 1998 : F factors

Table 2.10.5 North East Atlantic mackerel. Multifleet management option table assuming a catch constraint of 650 kt in 1998.

Year: 1998								
Northern			Southern			Total		
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass
1.1130	0.2196	616546	1.1130	0.0122	34288	650835	3547345	2648682
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes

Year: 1999									Year: 2000	
Northern			Southern			Total				
F Factor	Reference F	Catch in weight	F Factor	Reference F	Catch in weight	Catch in weight	Stock biomass	Sp.stock biomass	Stock biomass	Sp.stock biomass
0.0000	0.0000	0	0.0000	0.0000	0	0	3517813	2857443	4078387	3366835
0.1000	0.0197	60215	0.1000	0.0011	3381	63596	.	2836551	4019743	3288359
0.2000	0.0395	119333	0.2000	0.0022	6701	126034	.	2815824	3962182	3211965
0.3000	0.0592	177378	0.3000	0.0033	9961	187339	.	2795261	3905683	3137594
0.4000	0.0789	234369	0.4000	0.0044	13163	247532	.	2774860	3850224	3065188
0.5000	0.0986	290327	0.5000	0.0055	16308	306635	.	2754621	3795785	2994693
0.6000	0.1184	345274	0.6000	0.0066	19397	364671	.	2734541	3742344	2926054
0.7000	0.1381	399229	0.7000	0.0077	22432	421661	.	2714621	3689882	2859219
0.8000	0.1578	452211	0.8000	0.0088	25413	477624	.	2694857	3638380	2794137
0.9000	0.1776	504241	0.9000	0.0098	28341	532582	.	2675249	3587818	2730760
1.0000	0.1973	555336	1.0000	0.0109	31219	586554	.	2655796	3538178	2669038
1.1000	0.2170	605515	1.1000	0.0120	34045	639560	.	2636496	3489440	2608926
1.2000	0.2367	654796	1.2000	0.0131	36823	691619	.	2617348	3441588	2550379
1.3000	0.2565	703197	1.3000	0.0142	39552	742749	.	2598351	3394604	2493354
1.4000	0.2762	750735	1.4000	0.0153	42234	792969	.	2579504	3348470	2437806
1.5000	0.2959	797427	1.5000	0.0164	44870	842297	.	2560805	3303170	2383696
1.6000	0.3156	843289	1.6000	0.0175	47460	890749	.	2542253	3258686	2330984
1.7000	0.3354	888338	1.7000	0.0186	50006	938344	.	2523847	3215004	2279630
1.8000	0.3551	932590	1.8000	0.0197	52508	985098	.	2505586	3172107	2229596
1.9000	0.3748	976060	1.9000	0.0208	54968	1031028	.	2487468	3129979	2180847
2.0000	0.3946	1018763	2.0000	0.0219	57386	1076149	.	2469492	3088605	2133346
-	-	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANELT01
Date and time : 040CT98:10:24
Computation of ref. F: Northern: Simple mean, age 4 - 8
Southern: Simple mean, age 4 - 8
Basis for 1998 : F factors

Table 2.11.1 Mackerel Northeast Atlantic: Input data for the linear sensitivity analysis.

Name	Value	C.V.	Name	Value	C.V.
Population at age in 1998			Exploitation pattern		
N0	3872	0.0188	sH0	0.01	0.56
N1	3299	0.4066	sH1	0.03	2.69
N2	2716	0.3264	sH2	0.08	0.38
N3	3012.5	0.2789	sH3	0.14	0.38
N4	1238.6	0.2591	sH4	0.18	0.37
N5	1429.3	0.2529	sH5	0.20	0.00
N6	744.5	0.2506	sH6	0.20	0.37
N7	435.9	0.2445	sH7	0.22	0.37
N8	251.4	0.2464	sH8	0.23	0.37
N9	313.6	0.2446	sH9	0.28	0.37
N10	154.5	0.2609	sH10	0.26	0.37
N11	167.1	0.2715	sH11	0.25	0.00
N12	228.2	0.2715	sH12	0.25	0.00
Catch weight at age			Stock weight at age		
WH0	0.069	0.2218	WS0	0	0
WH1	0.143	0.0287	WS1	0.084	0
WH2	0.230	0.0628	WS2	0.168	0.1372
WH3	0.314	0.0415	WS3	0.2503	0.0494
WH4	0.375	0.0195	WS4	0.3143	0.0406
WH5	0.431	0.033	WS5	0.3713	0.0501
WH6	0.479	0.0283	WS6	0.4287	0.0416
WH7	0.513	0.0252	WS7	0.4657	0.0277
WH8	0.551	0.0347	WS8	0.4963	0.0417
WH9	0.574	0.0155	WS9	0.542	0.0858
WH10	0.593	0.026	WS10	0.541	0.0621
WH11	0.608	0.0595	WS11	0.587	0.0115
WH12	0.659	0.0354	WS12	0.6247	0.0538
Natural mortality at age			Maturity		
M0	0.15	0.1	MT0	0.00	0.0
M1	0.15	0.1	MT1	0.14	0.1
M2	0.15	0.1	MT2	0.65	0.1
M3	0.15	0.1	MT3	0.91	0.1
M4	0.15	0.1	MT4	0.97	0.1
M5	0.15	0.1	MT5	0.97	0.1
M6	0.15	0.1	MT6	0.99	0.1
M7	0.15	0.1	MT7	1.00	0.0
M8	0.15	0.1	MT8	1.00	0.0
M9	0.15	0.1	MT9	1.00	0.0
M10	0.15	0.1	MT10	1.00	0.0
M11	0.15	0.1	MT11	1.00	0.0
M12	0.15	0.1	MT12	1.00	0.0
Effort multiplier in year			Natural mortality multiplier in year		
HF1998	1	0.1	K1998	1	0.1
HF1999	1	0.1	K1999	1	0.1
HF2000	1	0.1	K2000	1	0.1
Recruitment in year					
R1999	3872	0.24			
R2000	3872	0.24			

Table 2.14.1 Western Mackerel: PA excel software add-in outputs (Input ICA_Mac.SEN file, Table 2.11.1).

Excel sheets of results included in the workbook W:\ACFM\WGMHSA\98\MAC_NEA\PA_Mac.XLS:

RefPts - provides stochastic output in the form of a table of reference points and a chart summarising the distributions of some reference points.

Plots - provides 5 plots:
A stock recruitment plot with a LOWESS smoother as a possible stock recruitment relationship. Some reference points are also indicated.
A plot of YPR and SPR curves with some reference points indicated.
A plot of historical SSB against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.
A plot of historical yield against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.
A plot of the time series of stock and recruitment with expected recruits based on the LOWESS stock recruitment relationship.

PD - gives the value of the reference points during each iteration of the simulation and the percentiles plotted on the chart on RefPts.

SV - contains the steady state vectors and stock recruitment series used. These can be used as the basis for further runs.

For estimation of Gloss and Floss:
A LOWESS smoother with a span of 0.5 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.

For estimation of the stock recruitment relationship used in equilibrium calculations:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were un-transformed
No point representing the origin was included in the stock recruit data.

Western Mackerel

Steady state selection averaged over 0 years.
Fbar averaged from age 4 to 8

Number of iterations = 100

Data source:	FishLab DLL used
W:\ACFM\WGMHSA\98\MAC_NEA\ICA_MAC.SEN	FLVB.DLL built on Jun 12 1998 at 15:59:40
W:\ACFM\WGMHSA\98\MAC_NEA\ICA_MAC.SUM	

Table 2.14.2 Reference points calculated for Western mackerel (standard output from PA software). Equivalent SSB reference points and recruitment estimates for the Northeast Atlantic mackerel can be obtained by applying a scaling factor of 1.09 (ratio between NEA and western mackerel, see sec. 2.9.1). The MBAL for NEA mackerel is 2,3 million tonnes.

Reference point	Deterministic	Median	95th percentile	80th percentile
Median Recruits	3405550	3405550	4690860	4045890
MBAL	2000000			
Bloss	2063211			
SSB90% R90% Surv	2231356	2361555	2536477	2463141
SPR% of Virgin	36.39	35.44	43.78	38.68
Virgin SPR	2.17	2.22	2.96	2.61
SPRloss	0.68	0.66	0.98	0.76

	Deterministic	Median	5th percentile	20th percentile
FBar	0.21	0.20	0.15	0.18
Fmax	0.56	0.53	0.35	0.41
F0.1	0.18	0.17	0.12	0.14
Flow	0.06	0.08	0.00	0.03
Fmed	0.23	0.24	0.15	0.19
Fhigh	0.54	0.51	0.31	0.40
F35%SPR	0.22	0.21	0.14	0.18
Floss	0.26	0.27	0.14	0.19

Figure 2.6.1.1 Effort data by fleet and area.

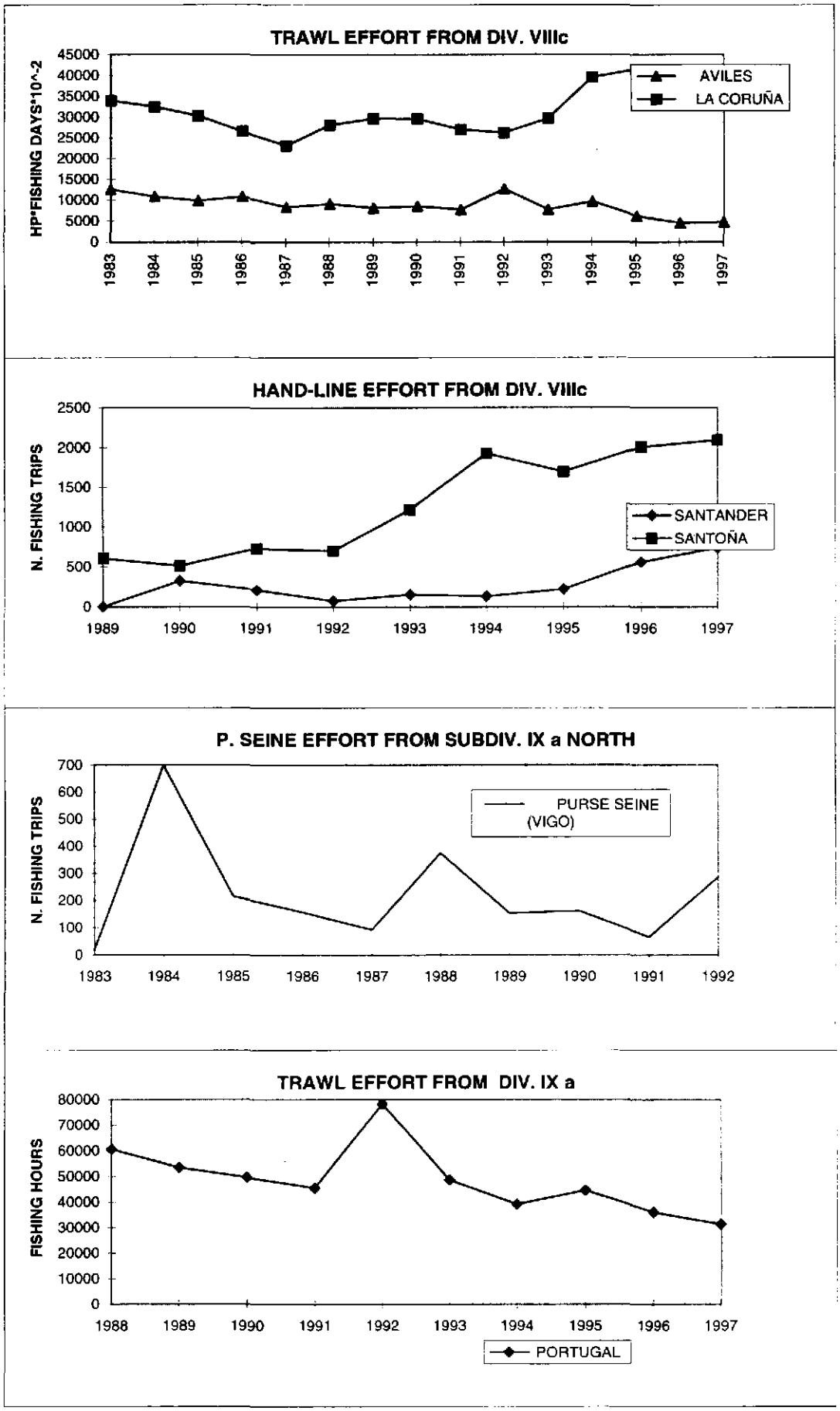


Figure 2.6.1.2 CPUE indices by fleet and area.

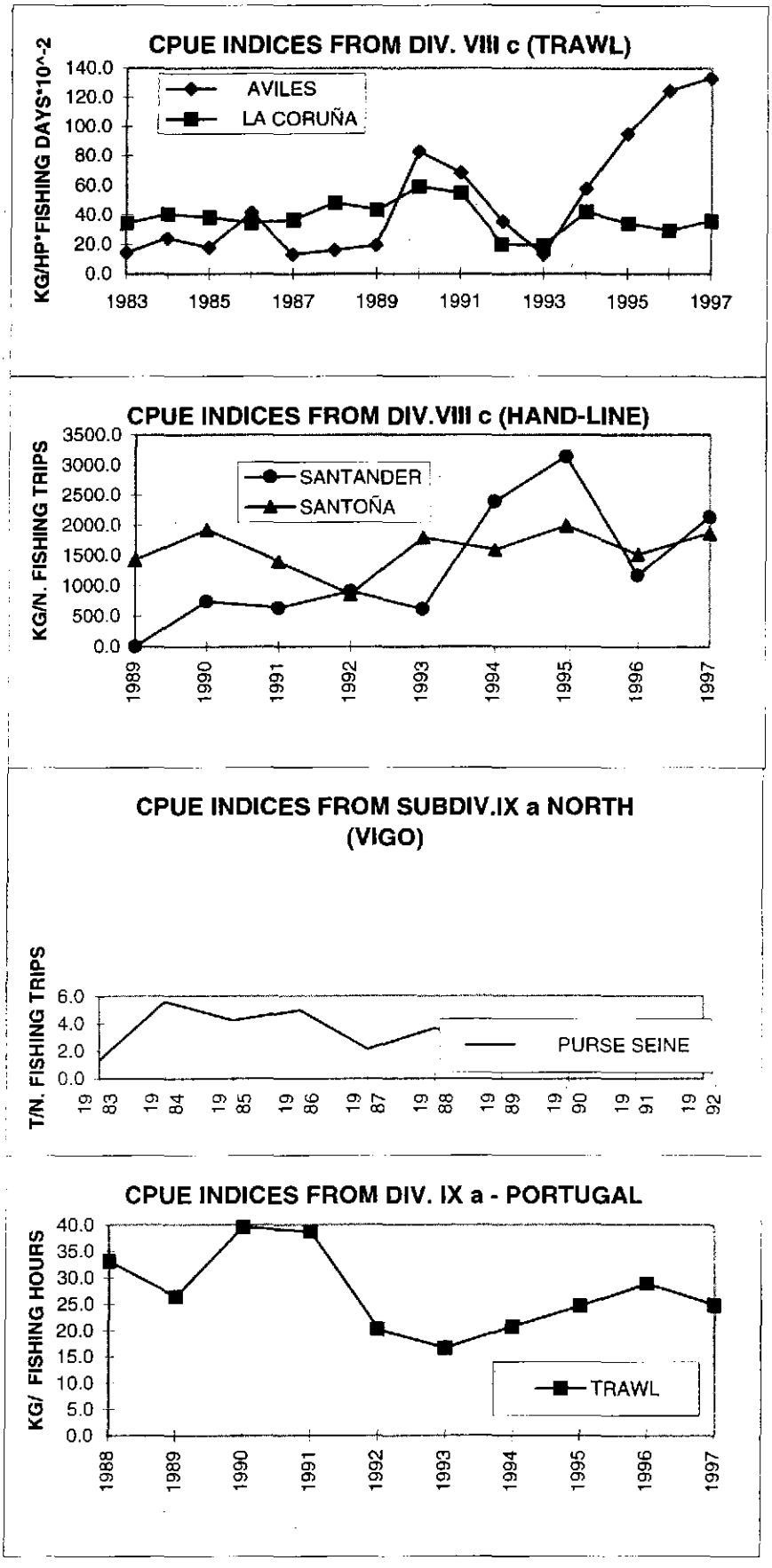


Figure 2.7.1.1 Mackerel commercial catches in Quarter 1 1997.

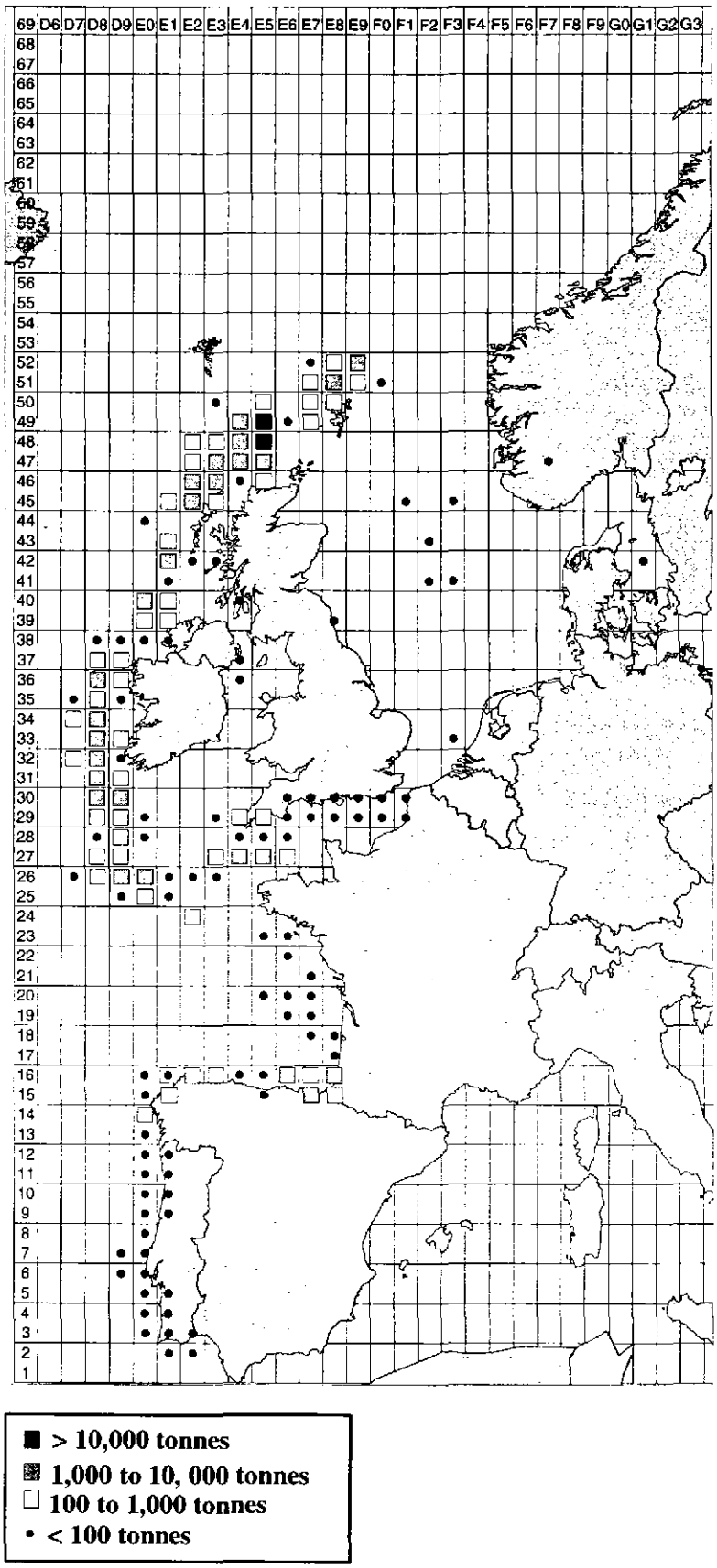
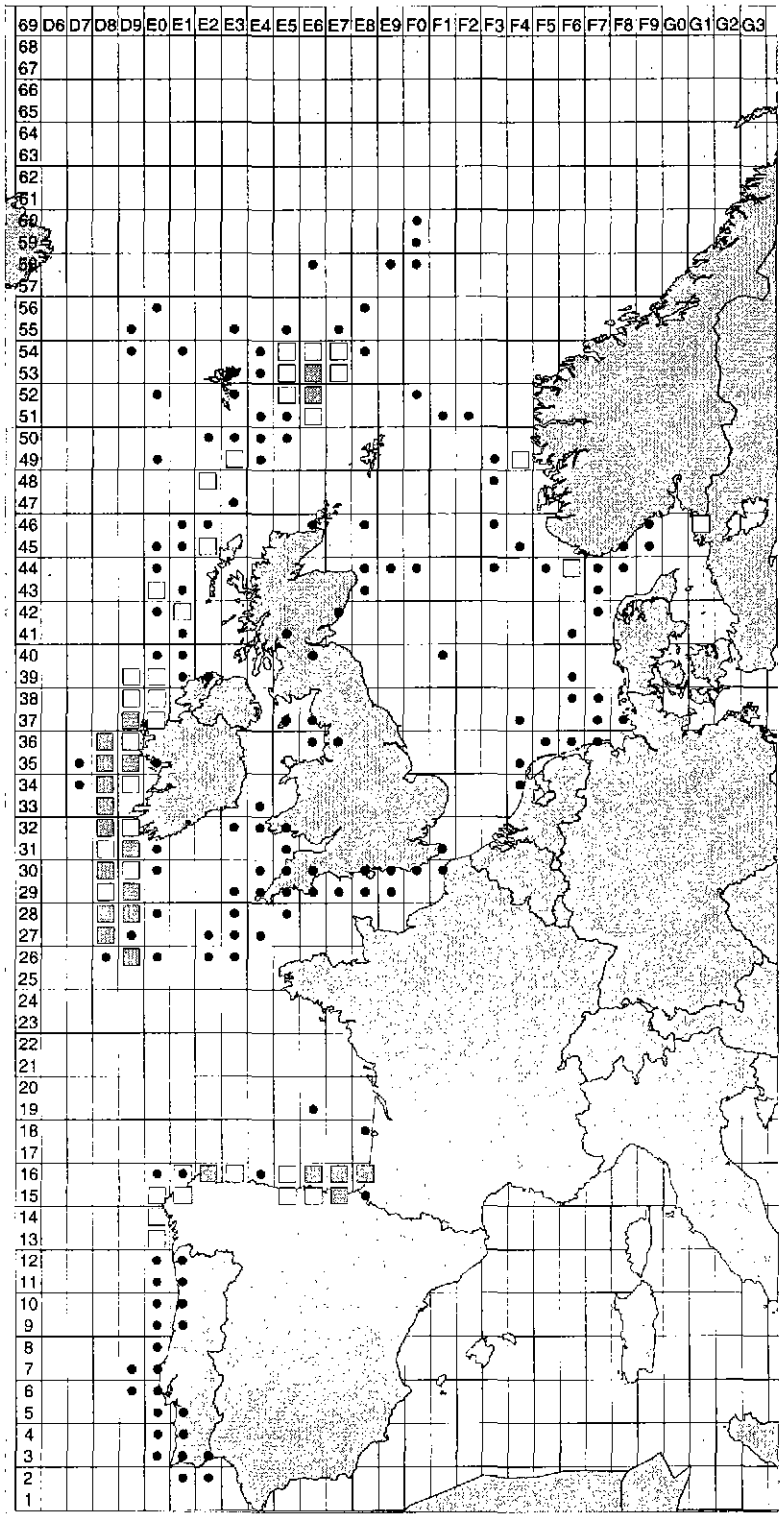
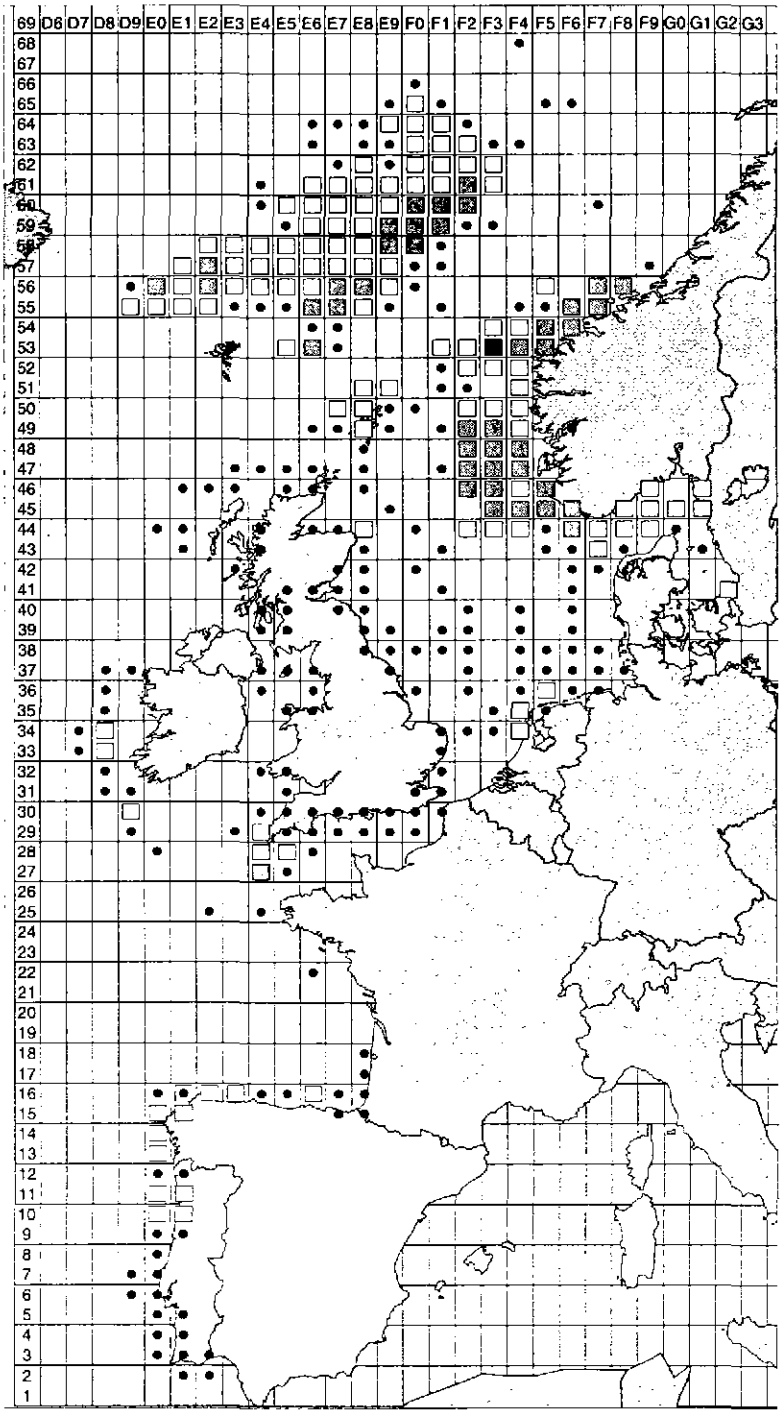


Figure 2.7.1.2 Mackerel commercial catches in Quarter 2 1997.



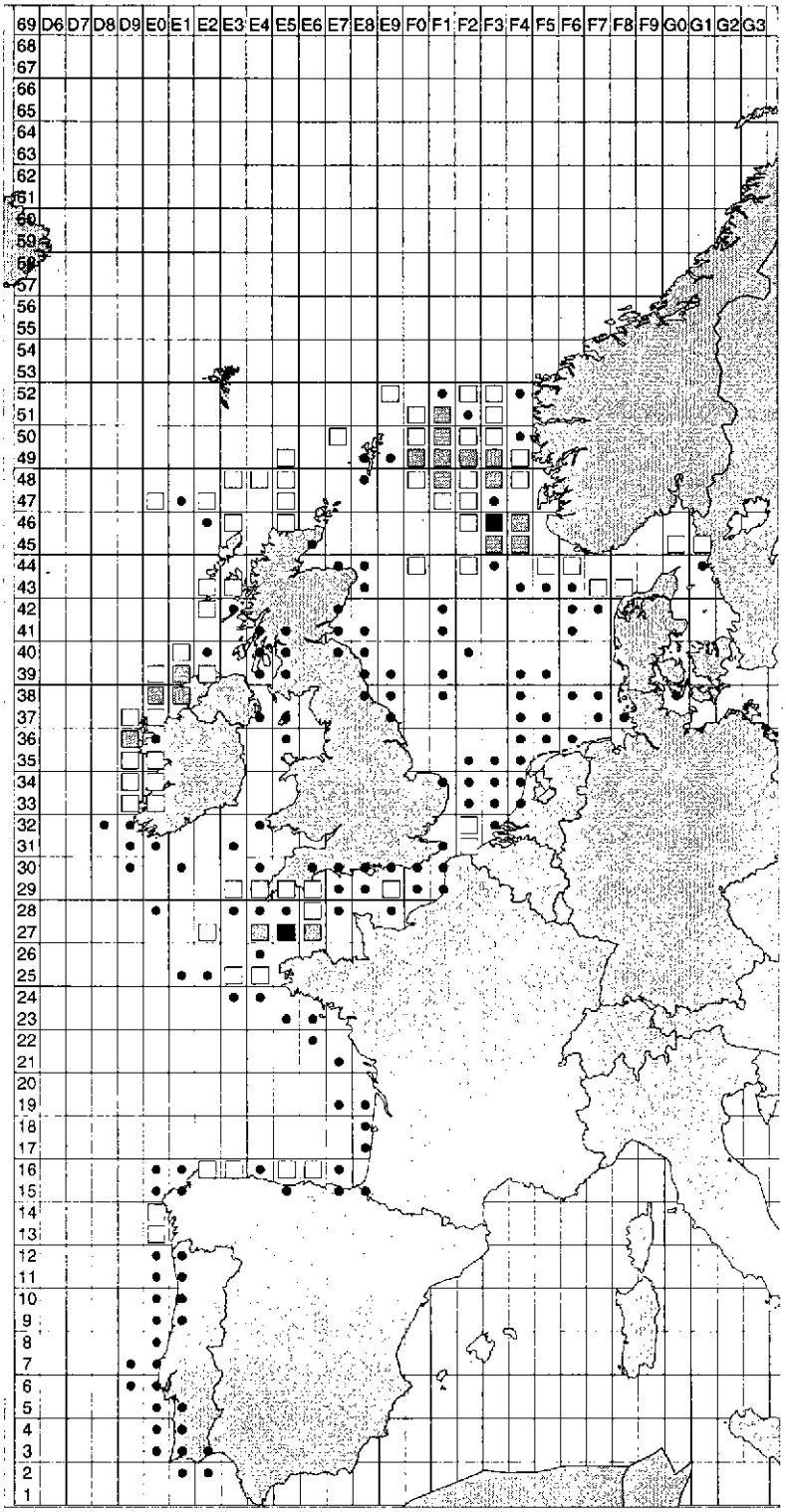
■ > 10,000 tonnes
▩ 1,000 to 10, 000 tonnes
□ 100 to 1,000 tonnes
• < 100 tonnes

Figure 2.7.1.3 Mackerel commercial catches in Quarter 3 1997.



■ > 10,000 tonnes
▩ 1,000 to 10, 000 tonnes
□ 100 to 1,000 tonnes
• < 100 tonnes

Figure 2.7.1.4 Mackerel commercial catches in Quarter 4 1997.



■ > 10,000 tonnes
▩ 1,000 to 10, 000 tonnes
□ 100 to 1,000 tonnes
• < 100 tonnes

Figure 2.7.2.1 Distribution of mackerel recruits. Quarter 4 – Age 0 - 1997 (Catch rates per hour).

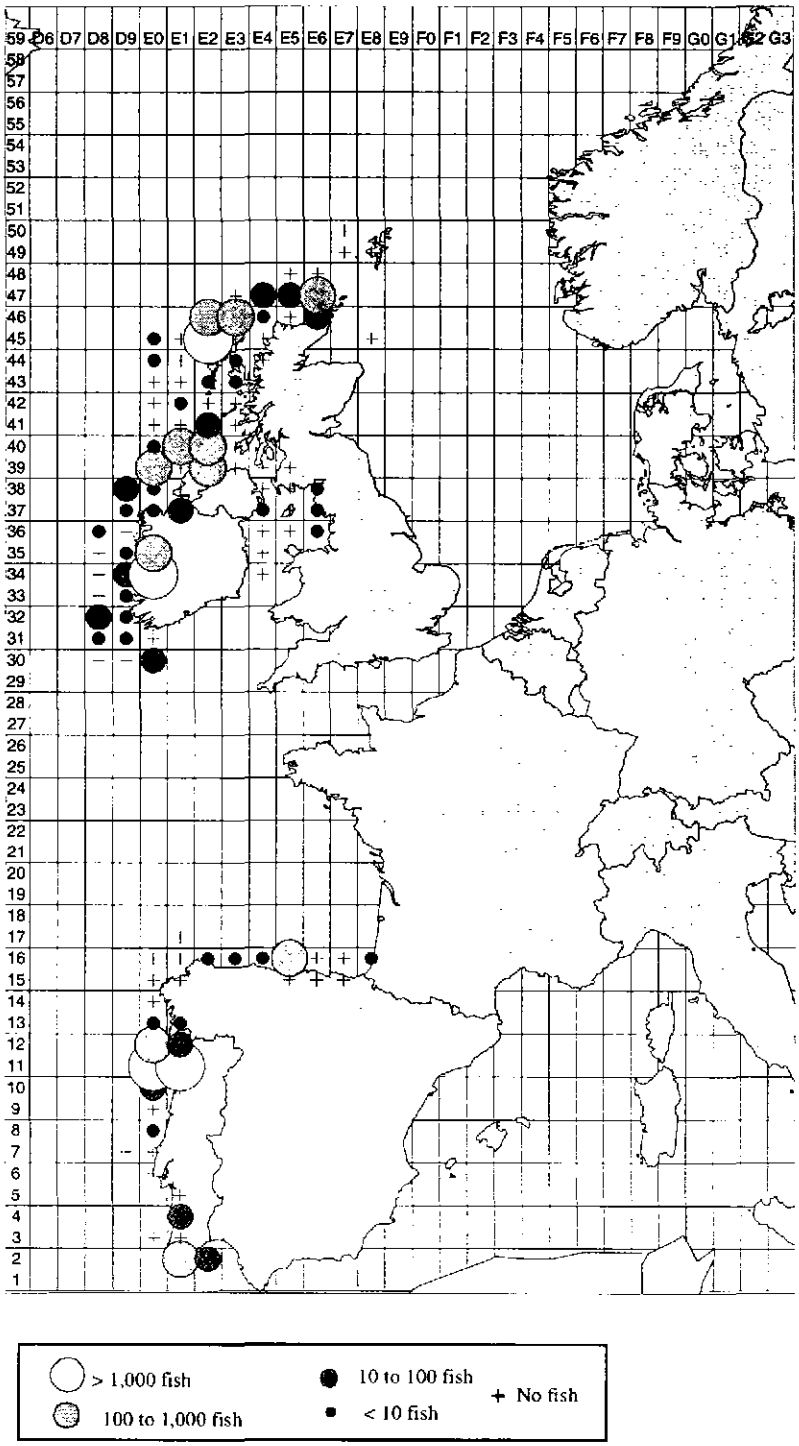


Figure 2.7.2.2 Distribution of mackerel recruits. Quarter 4 – Age 1 - 1997 (Catch rates per hour).

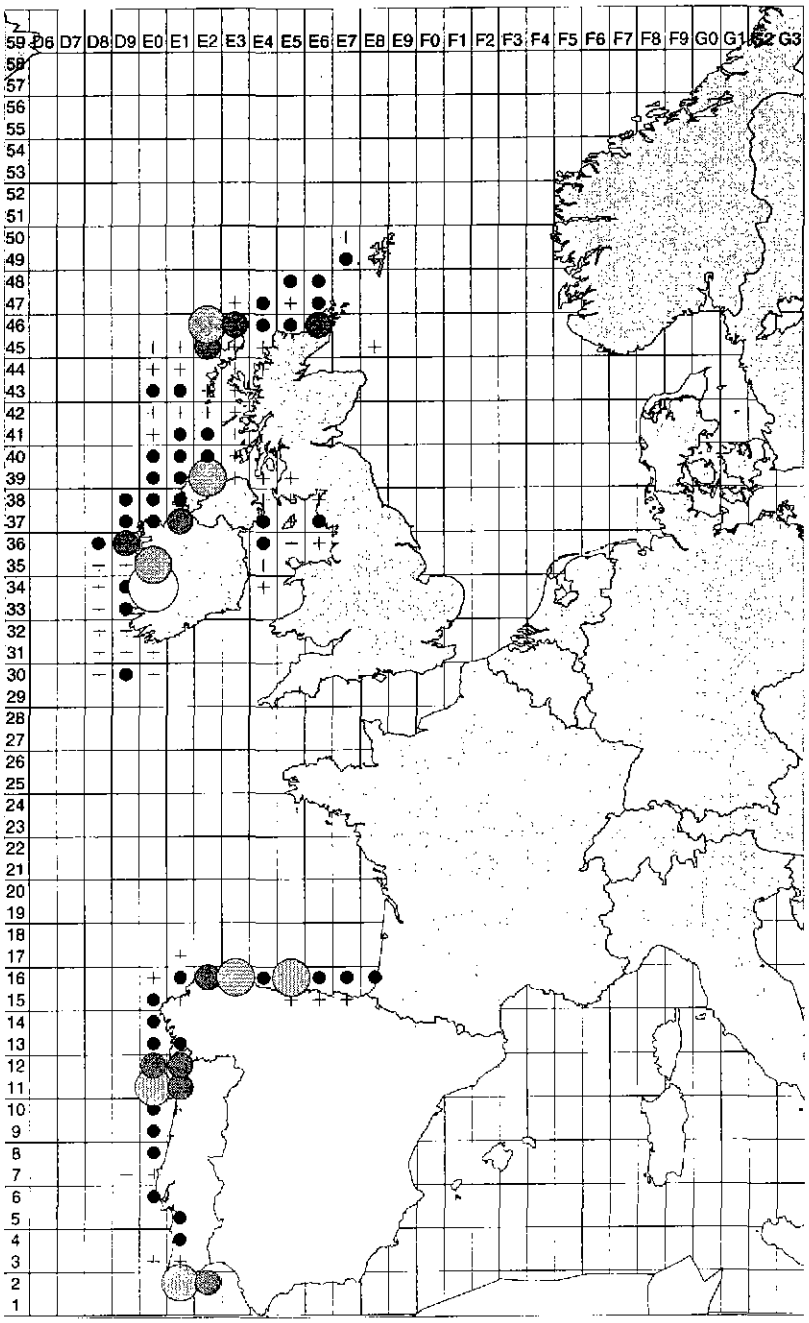


Figure 2.7.2.3 Distribution of mackerel recruits. Quarter 1 – Age 1 - 1998 (Catch rates per hour).

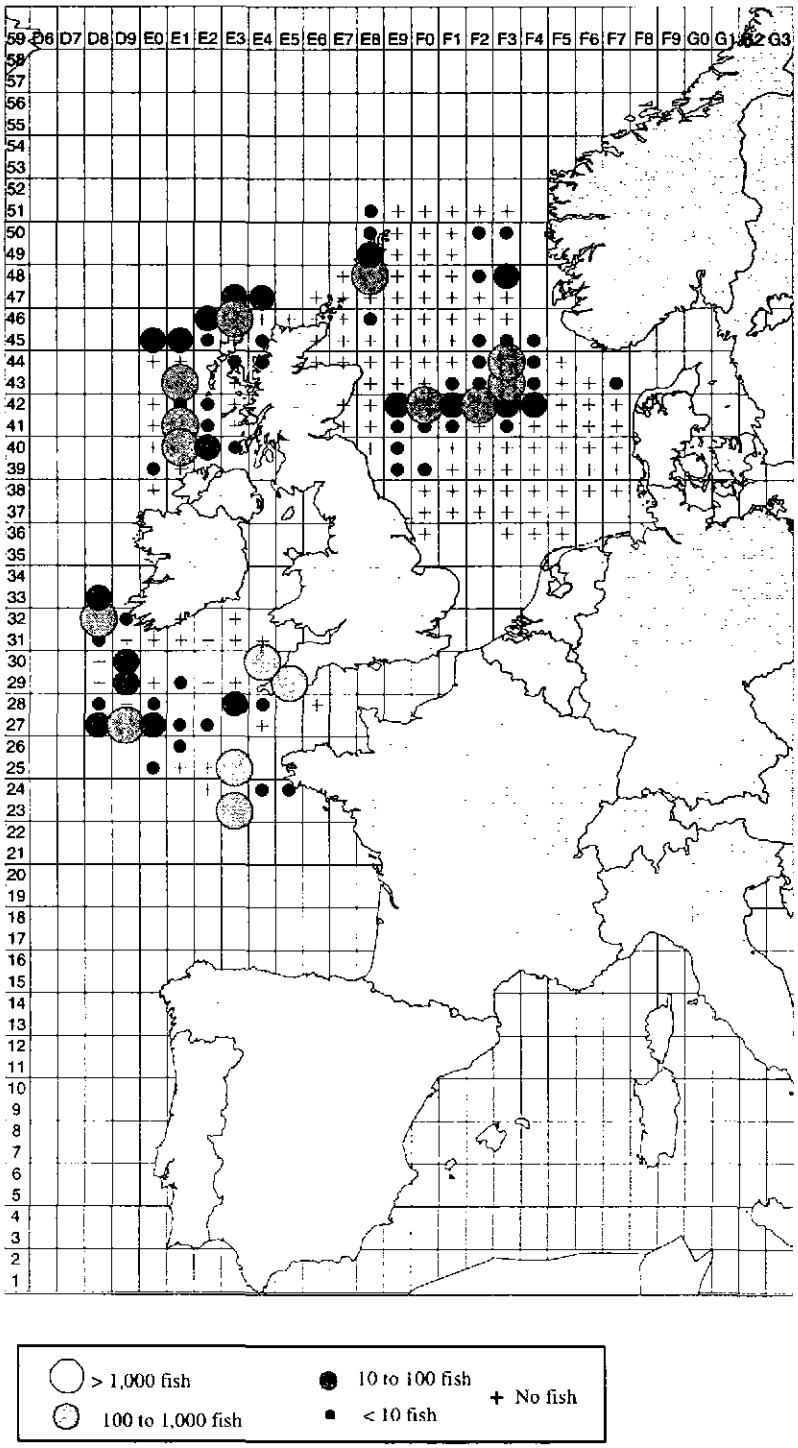


Figure 2.7.2.4 Distribution of mackerel recruits. Quarter 1 – Age 2 - 1998 (Catch rates per hour).

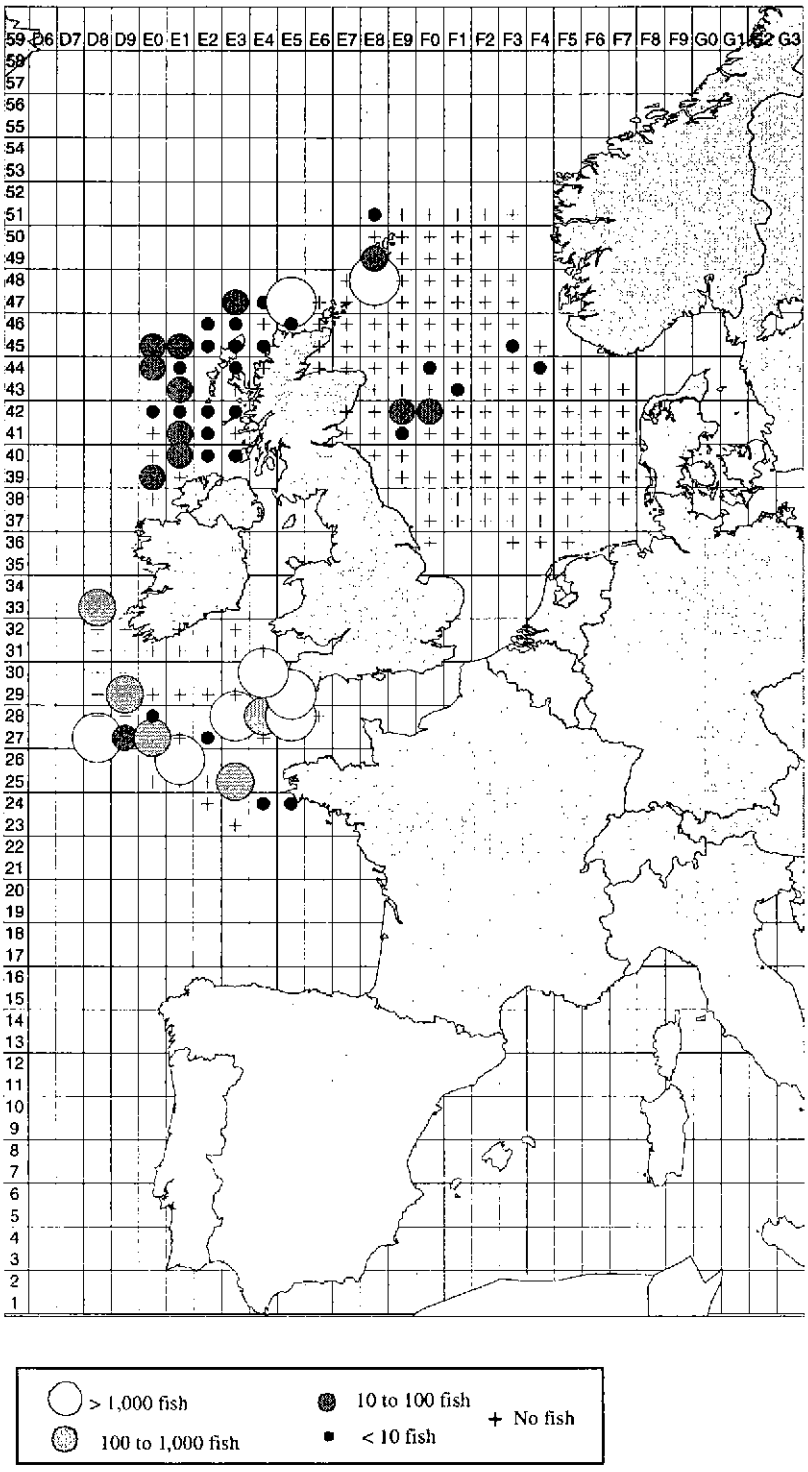


Figure 2.8.1 The time series of fCA estimated recruitments for the NEA mackerel and indices of abundance at age 0 and 1 from the mackerel trawl surveys.

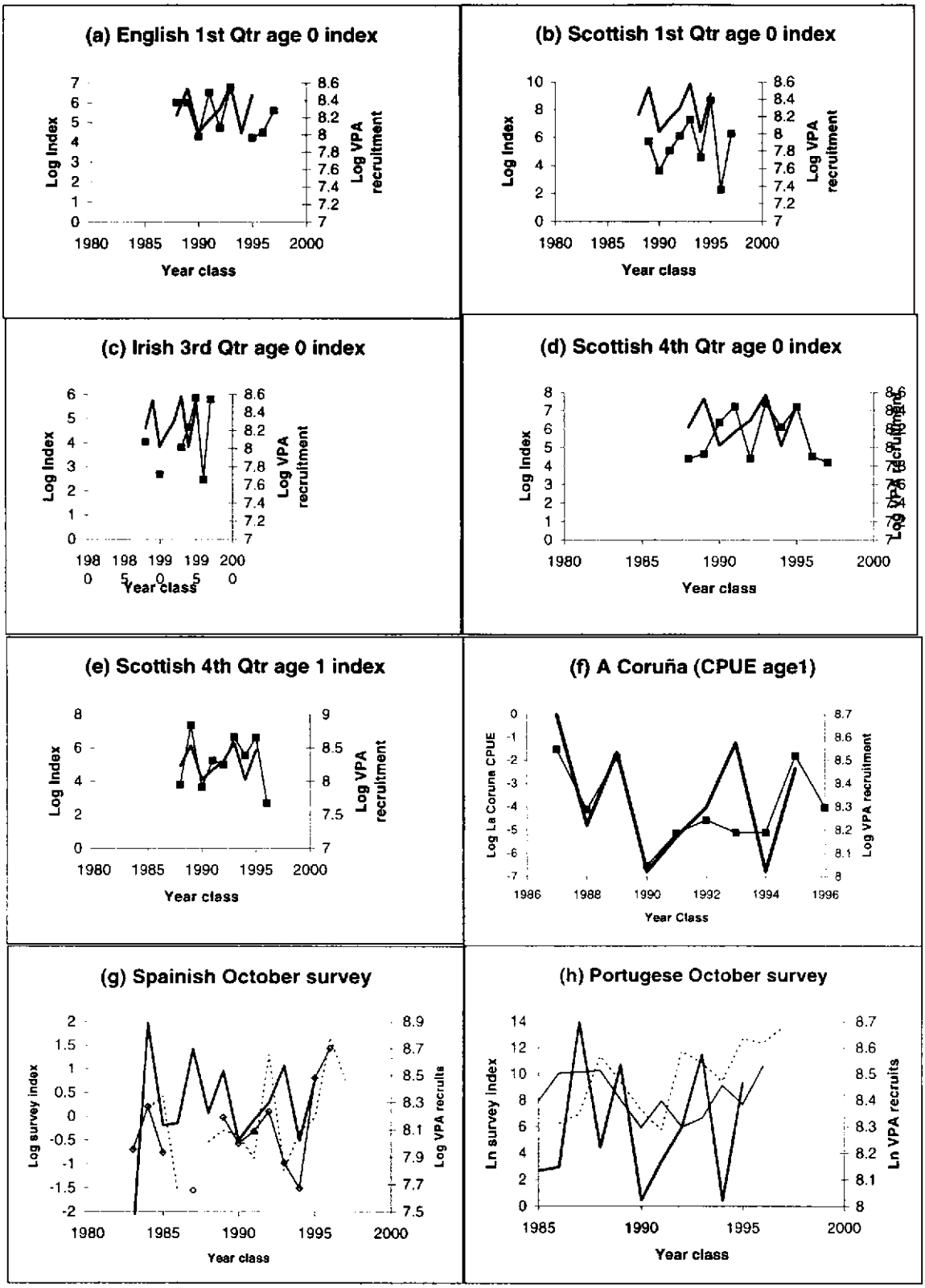


Figure 2.8.2 (a,b,c,d) A graphical presentation of the GAM stage 1 fitting a binomial model for a catch of age 0 Mackerel from the trawl surveys.

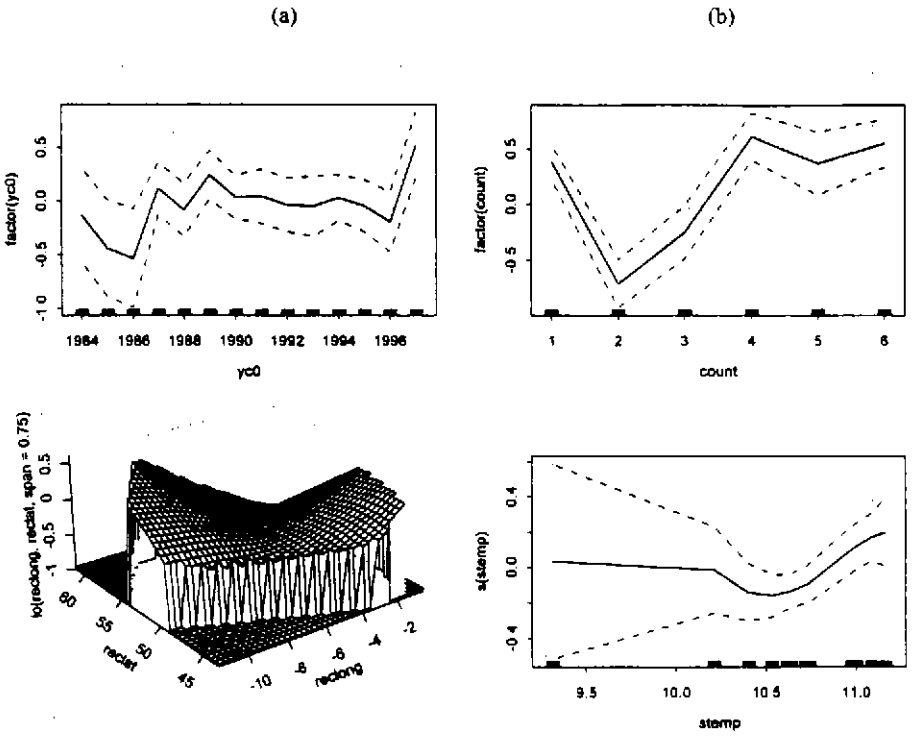


Figure 2.8.3 (a,b,c,d) A graphical presentation of the GAM stage 2 fitting catches at age 0 from the Mackerel trawl surveys.

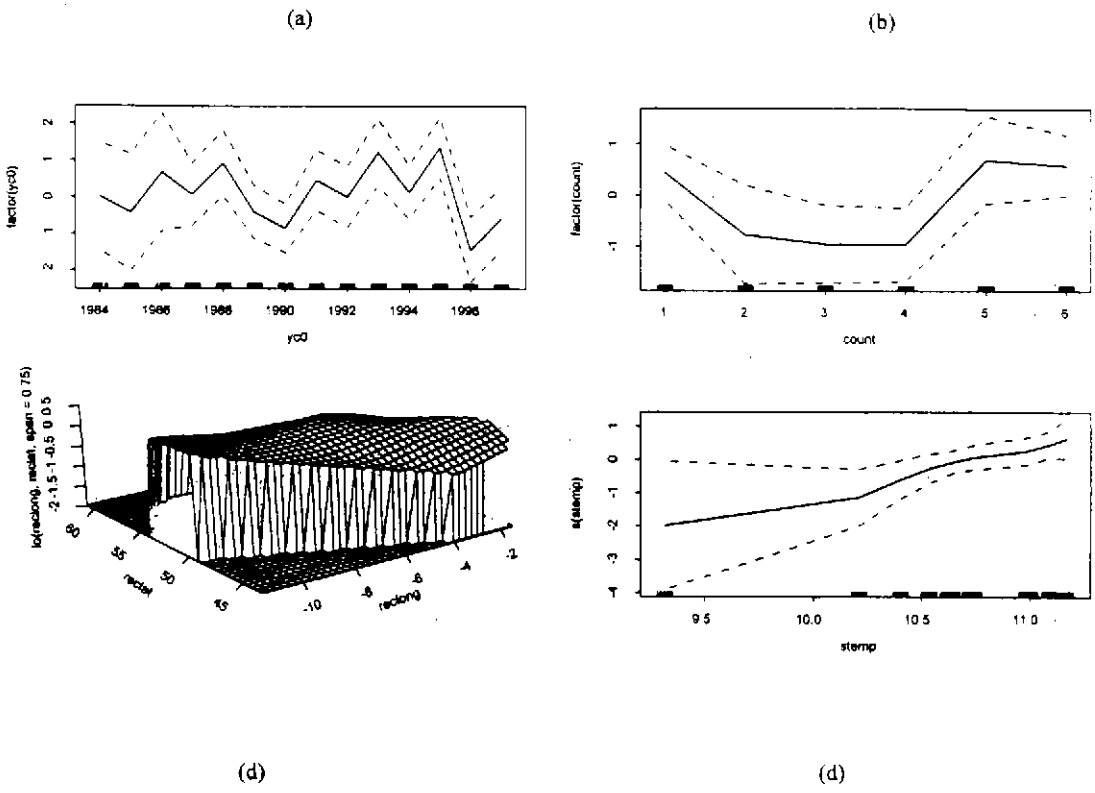


Figure 2.8.4 The ICA generated separable populations at age 0 and the GAM recruitment index.

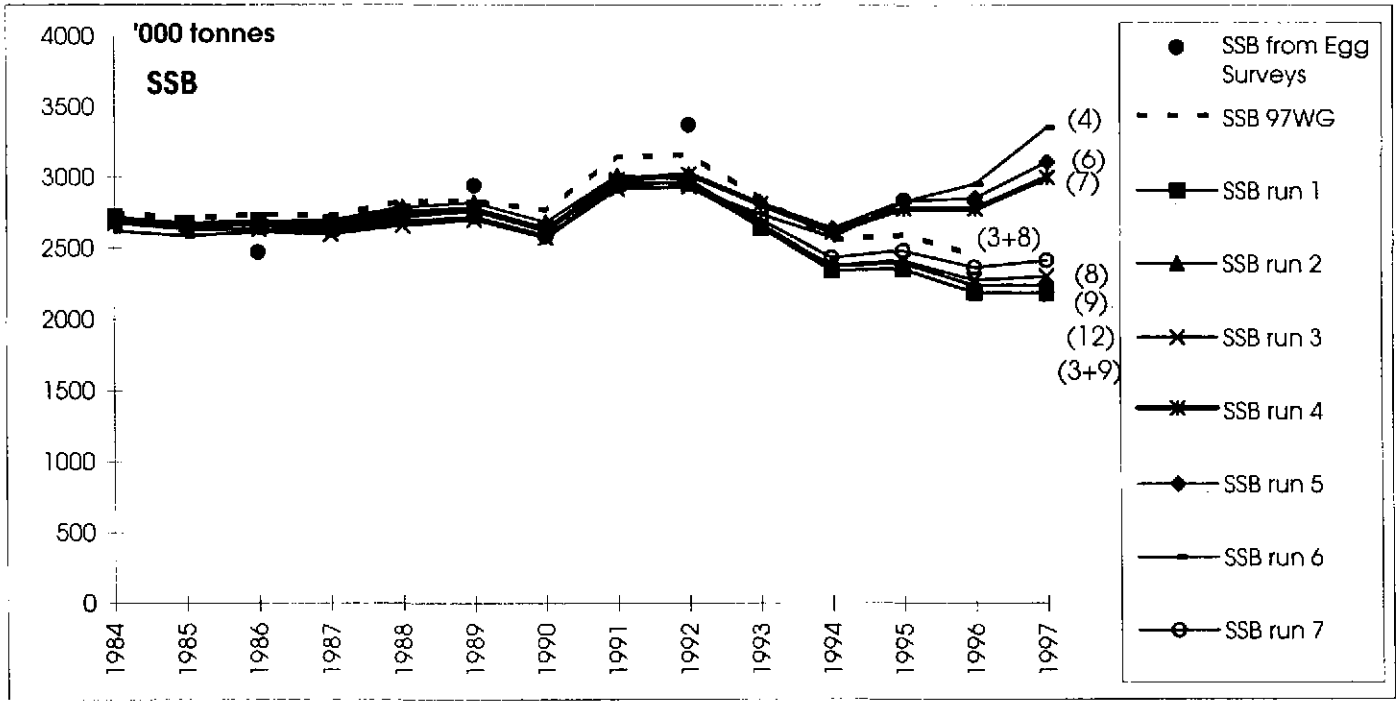


Fig.2.9.1.1 SSB's from egg surveys compared to SSB's from 7 different ICA runs. SSB's from 1997 WG report are shown for comparison (broken line). Numbers between brackets refer to years of separable constraint.

run 1 = Two separable contraint periods: 1986-1988 + 1989-1997 (3+9 years)
run 2 = One separable contraint period: 1986-1997 (12 years)
run 3 = One separable contraint period: 1989-1997 (9 years)
run 4 = One separable contraint period: 1991-1997 (7 years)
run 5 = One separable contraint period: 1992-1997 (6 years)
run 6 = One separable contraint period: 1994-1997 (4 years)
run 7 = One separable contraint period: 1990-1997 (8 years)

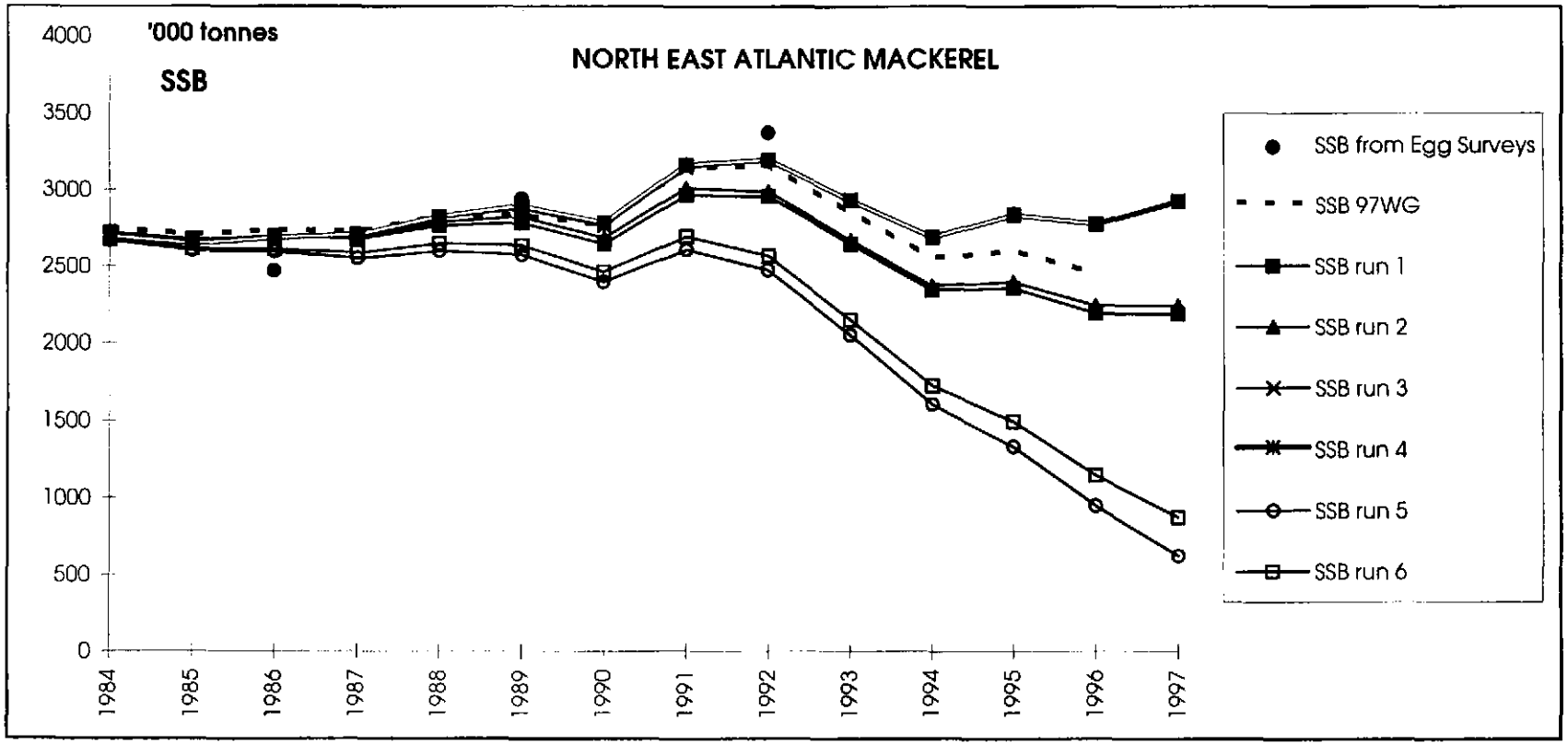


Fig. 2.9.1.2 SSB's from egg surveys compared to SSB's from 6 different ICA runs. SSB's from 1997 WG report are shown for comparison (broken line). Numbers between brackets refer to years of separable constraint.

run 1 = Two separable contraint periods: 1986-1988 + 1989-1997 (3+9 years) SSB weighting 1
run2 = One separable contraint period: 1986-1997 (12 years) SSB weighting 1
run 3 = Two separable contraint periods: 1986-1988 + 1989-1997 (3+9 years) SSB weighting 10
run 4 = One separable contraint period: 1986-1997 (12 years) SSB weighting 10
run 5 = Two separable contraint periods: 1986-1988 + 1989-1997 (3+9 years) SSB weighting 0.1
run 6 = One separable contraint period: 1986-1997 (12 years) SSB weighting 0.1

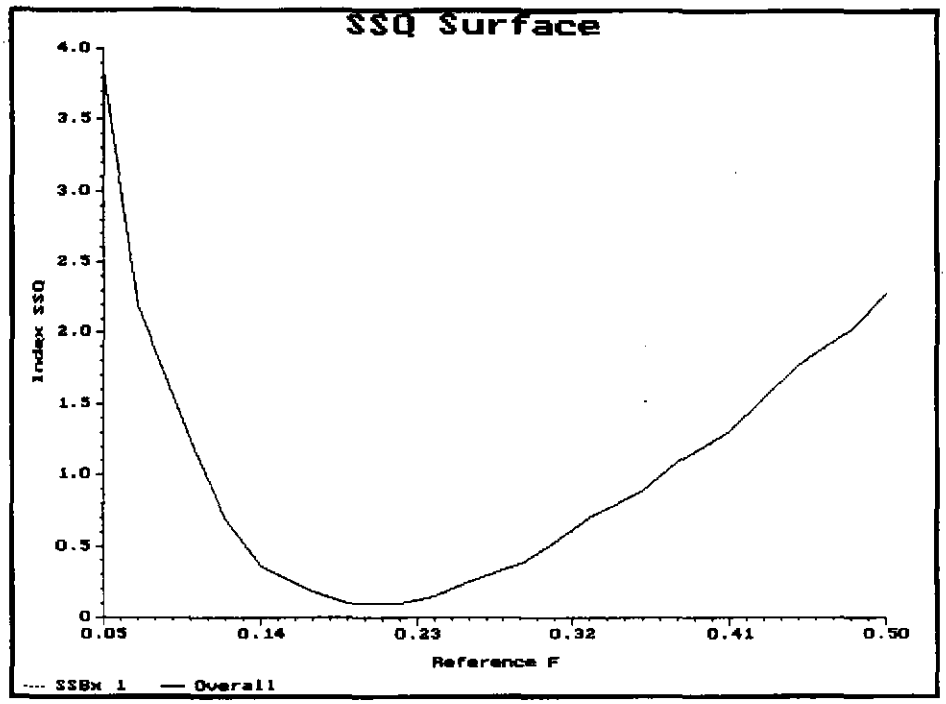


Figure 2.9.1.3 The sum of squares surface for the ICA separable VPA fit to the North East Atlantic Mackerel egg survey spawning stock biomass estimates of which the 1998 estimate is preliminary.

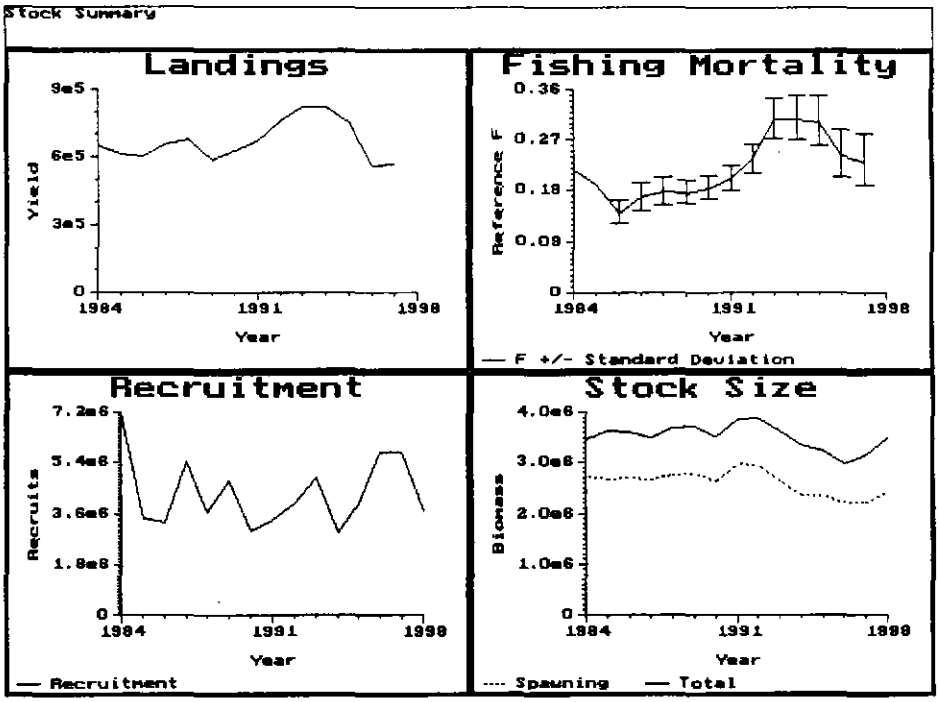


Figure 2.9.1.4 The long term trends in stock parameters for the North East Atlantic Mackerel. The 1998 stock biomass estimate from the egg surveys is preliminary.

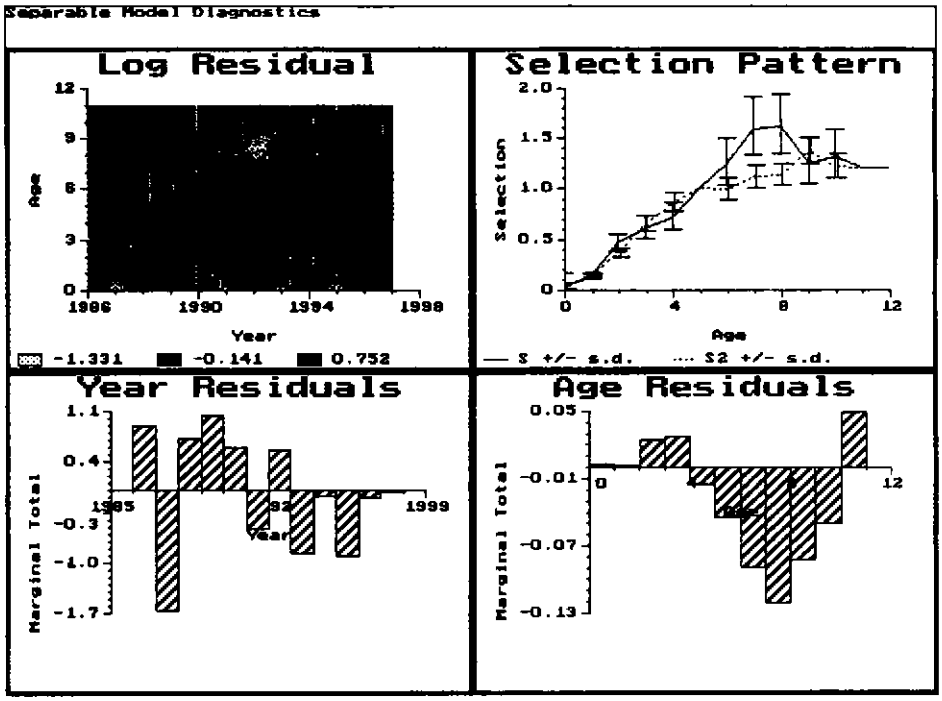


Figure 2.9.1.5 The catch at age residuals and selection at age as fitted by ICA to the North East Atlantic Mackerel data. The 1998 stock biomass estimate from the egg surveys is preliminary.

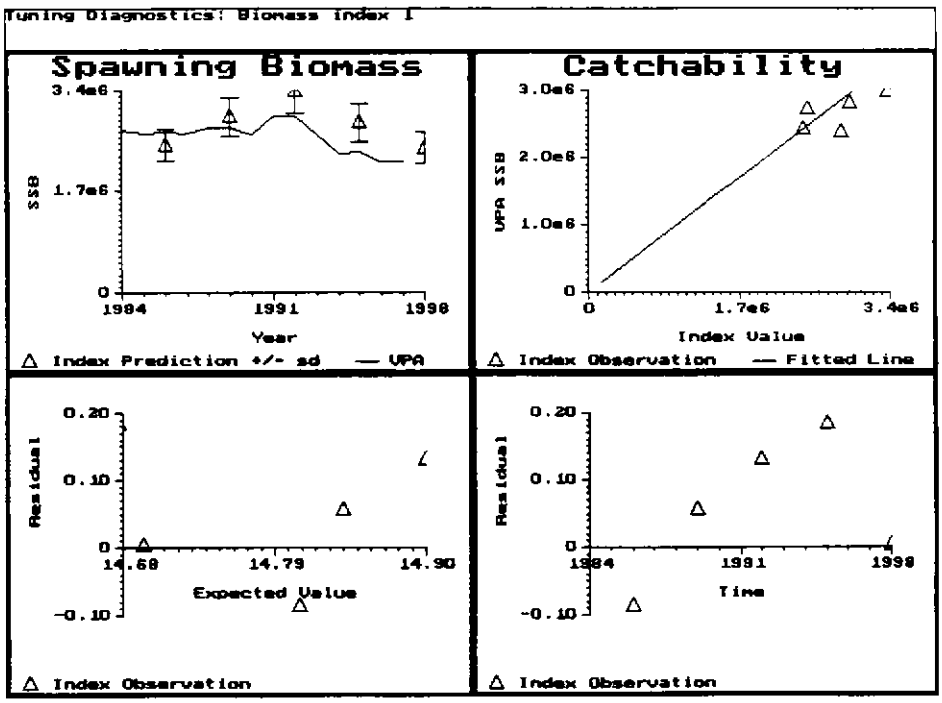


Figure 2.9.1.6 The diagnostics for the egg production index as fitted by ICA to the North East Atlantic Mackerel data. The 1998 stock biomass estimate from the egg surveys is preliminary.

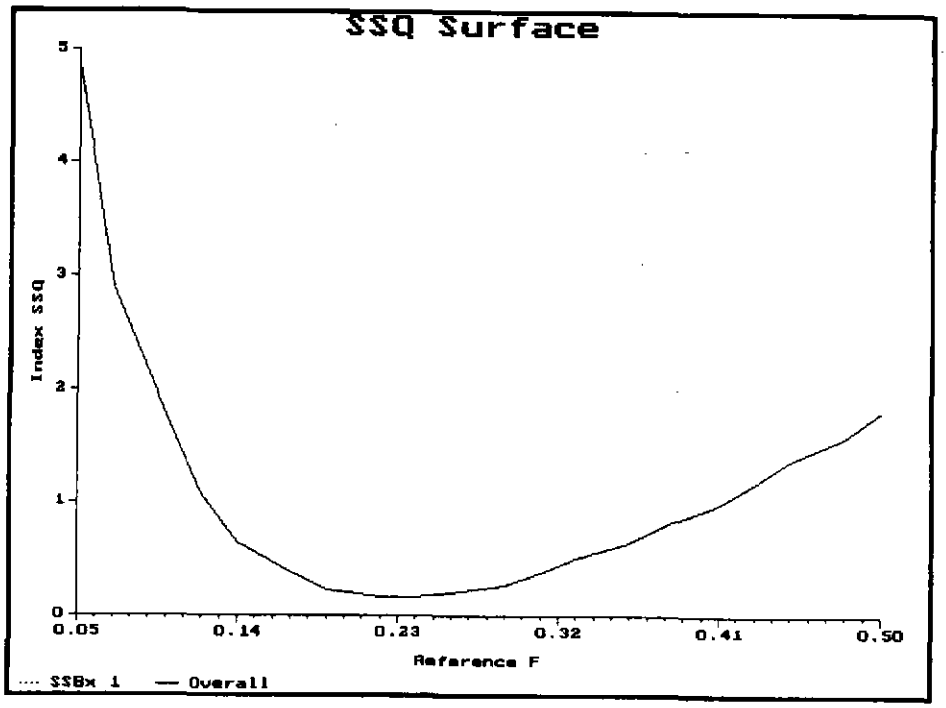


Figure 2.9.1.7 The sum of squares surface for the ICA separable VPA fit to the Western Mackerel egg survey spawning stock biomass estimates of which the 1998 estimate is preliminar.

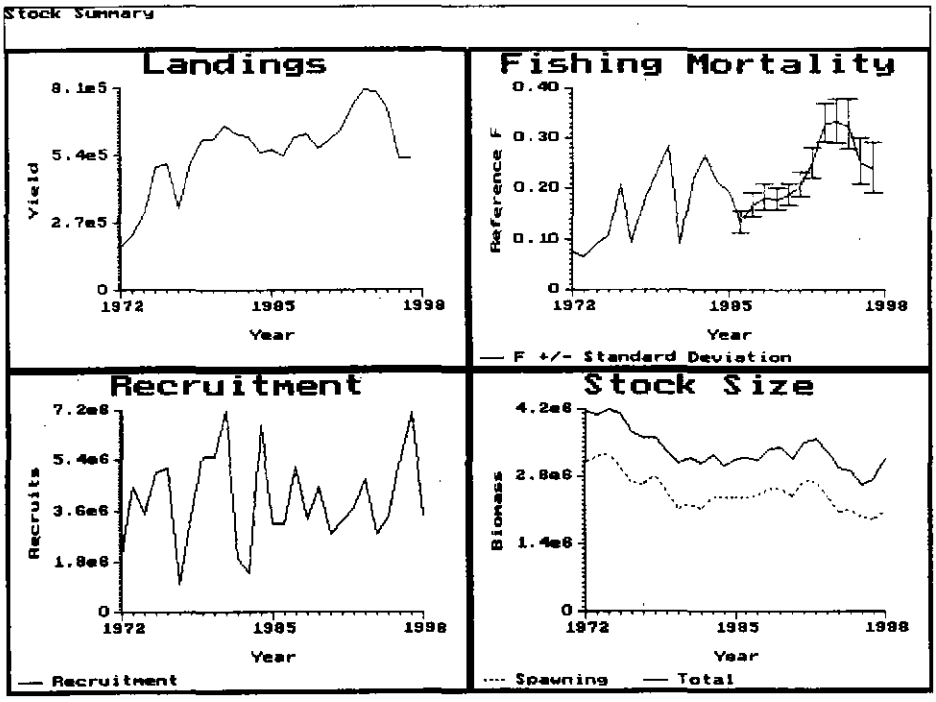


Figure 2.9.1.8 The long term trends in stock parameters for the Western Mackerel. The 1998 stock biomass estimate from the egg surveys is preliminar.

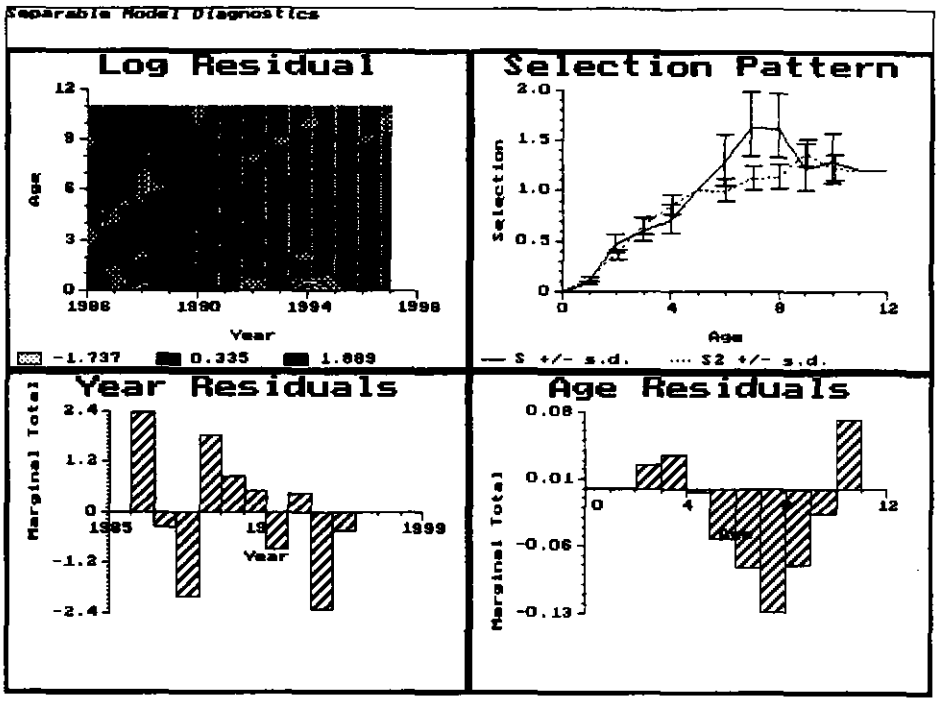


Figure 2.9.1.9 The catch at age residuals and selection at age as fitted by ICA to the Western Mackerel data. The 1998 stock biomass estimate from the egg surveys is preliminar.

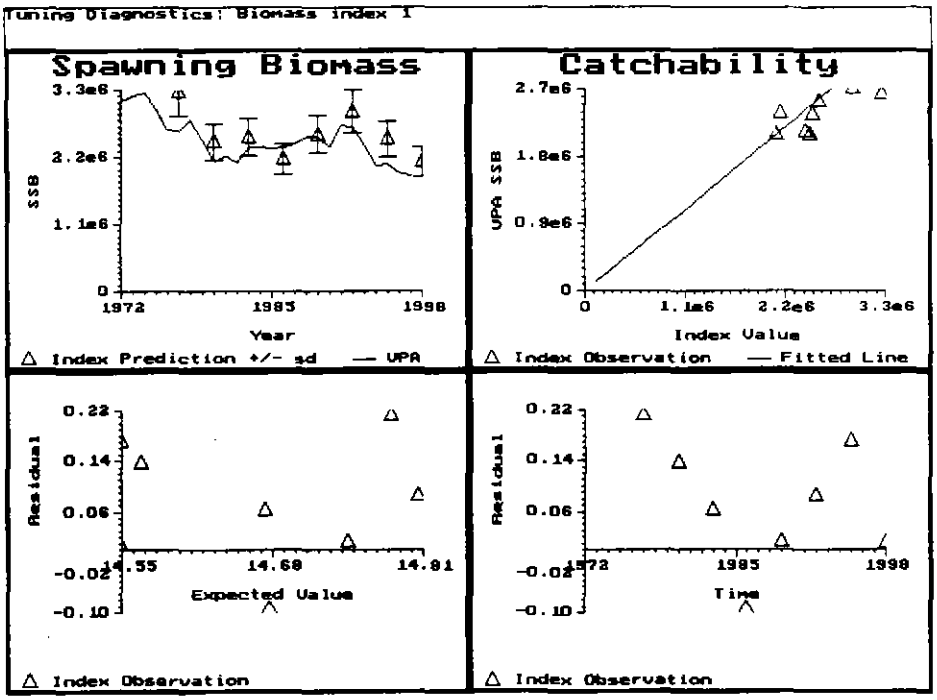


Figure 2.9.1.10 The diagnostics for the egg production index as fitted by ICA to the Western Mackerel data. The 1998 stock biomass estimate from the egg surveys is preliminar.

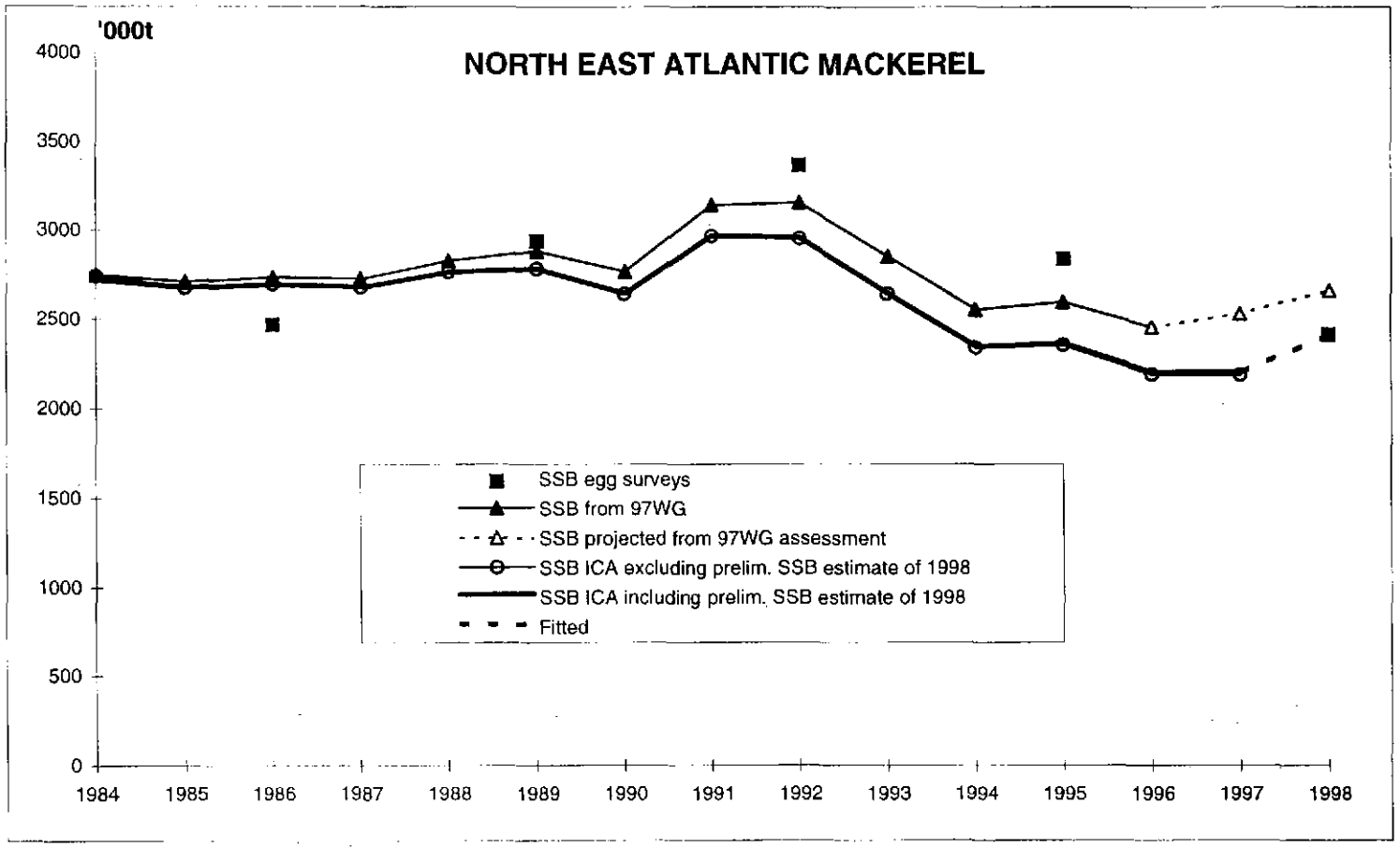


Figure 2.9.1.11 **Spawning stock biomass obtained from ICA excluding and including the preliminar 1998 egg survey biomass estimate compared to the biomass estimates from the egg surveys. The spawing stock biomass estimates from last years assessment (97WG) together with the projections are also shown for comparison.**

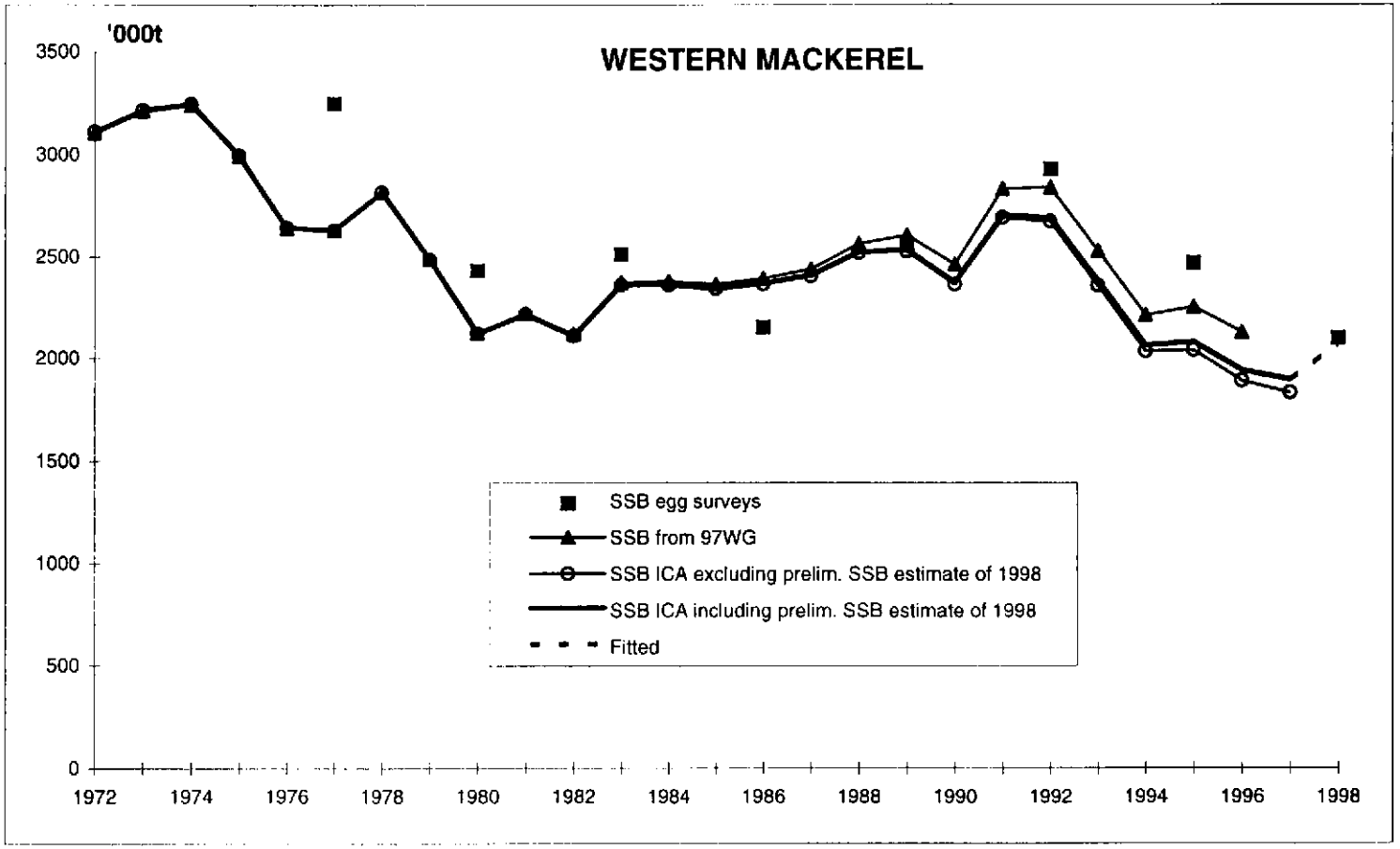


Figure 2.9.1.12 **Spawning stock biomass obtained from ICA excluding and including the preliminar 1998 egg survey biomass estimate compared to the biomass estimates from the egg surveys. The spawing stock biomass estimates from last years assessment (97WG) are also shown for comparison.**

Figure 2.11.1 Mackerel, All areas. Sensitivity analysis of short term forecast.

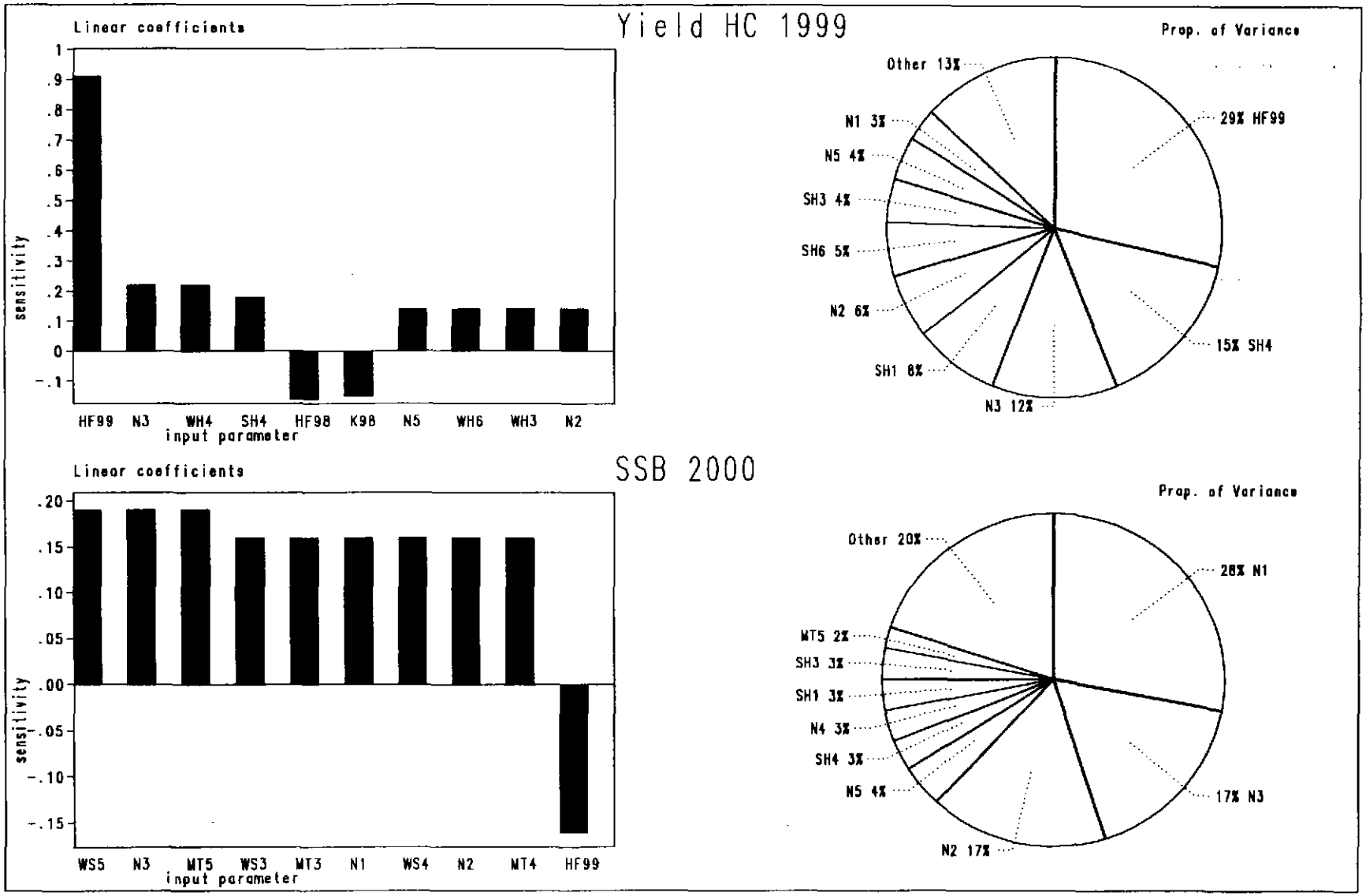


Figure 2.13.1 NEA mackerel multifleet yield per recruit

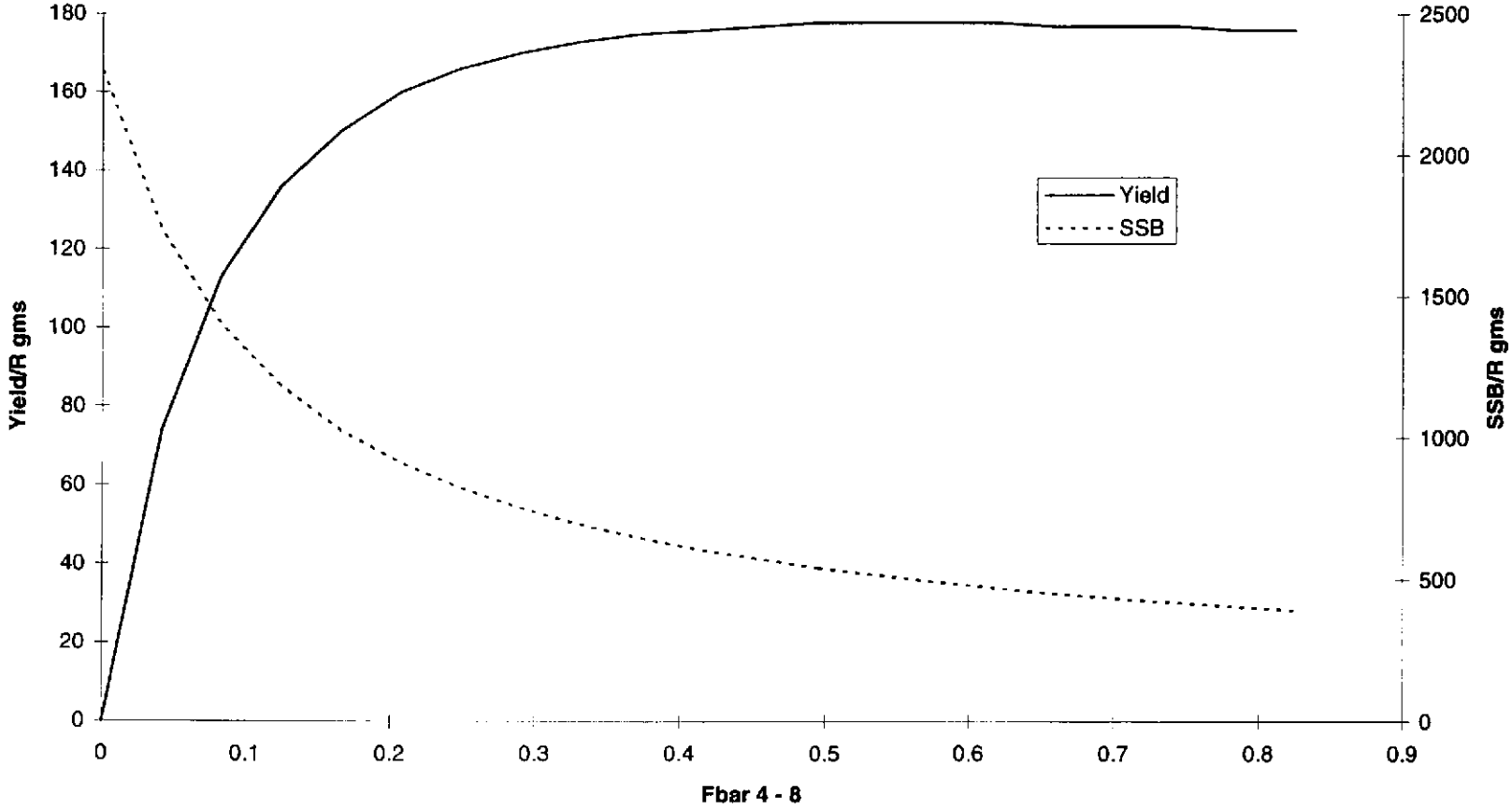


Figure 2.14.1 Stock-recruitment plot with a LOWESS smoother as a possible stock recruitment relationship. Some reference points are also indicated.

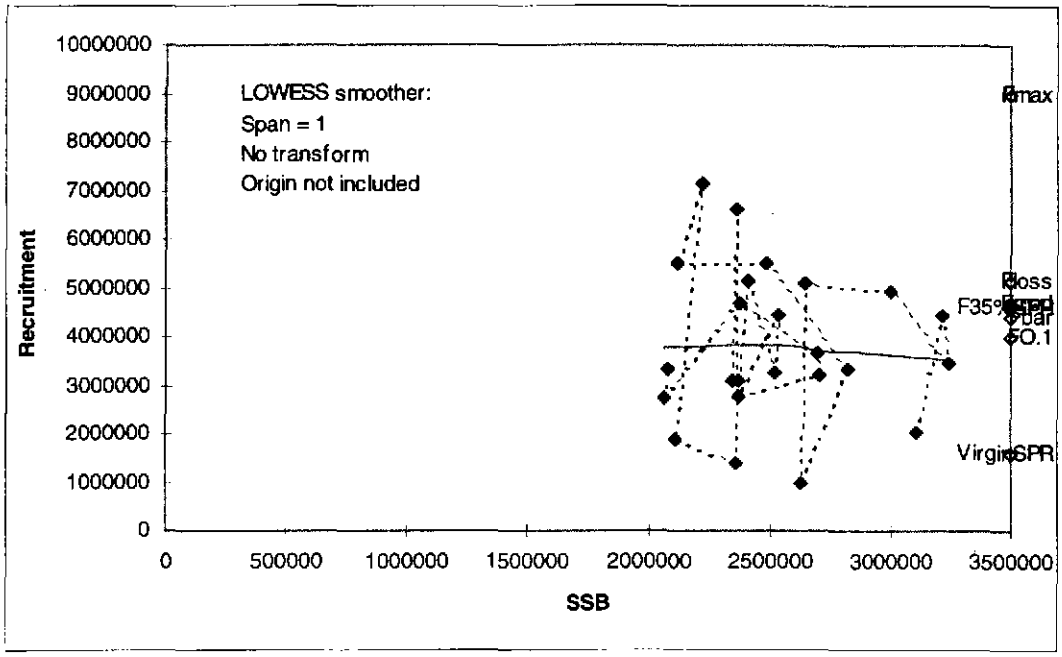


Figure 2.14.2 Plot of YPR and SPR curves with some reference points indicated for Western mackerel.

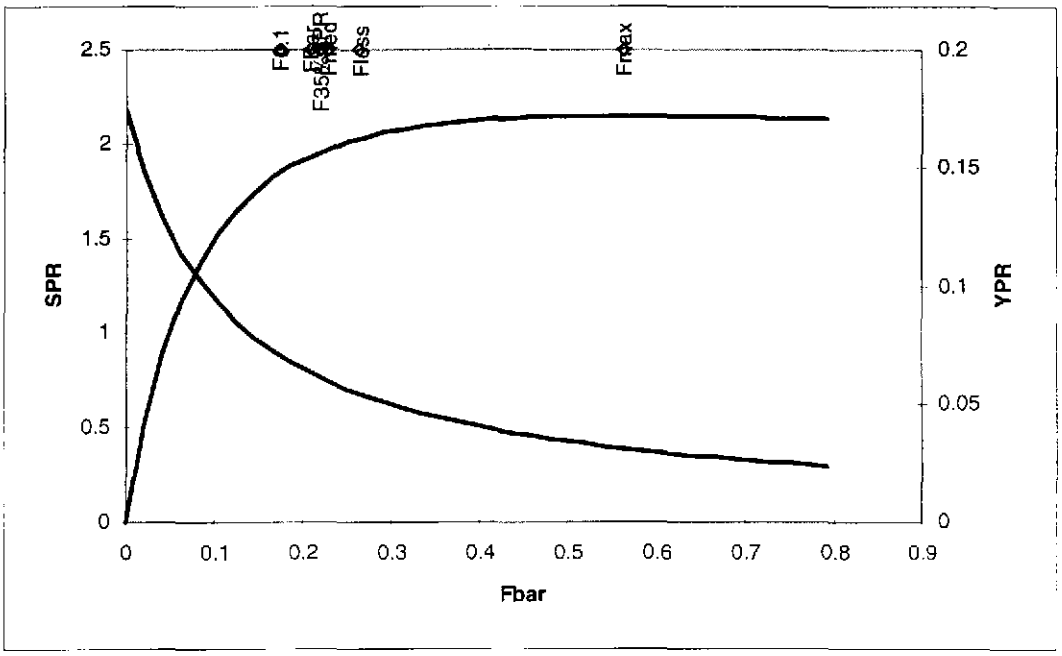


Figure 2.14.3 Plot of historical SSB against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship for Western mackerel.

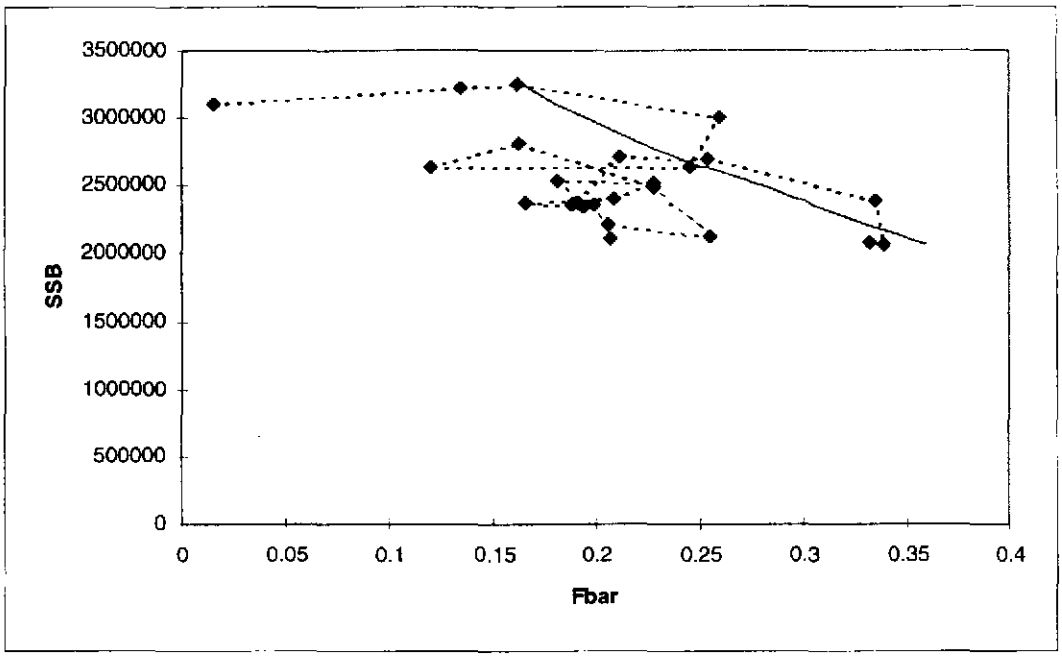


Figure 2.14.4 Plot of historical yield against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship for Western mackerel.

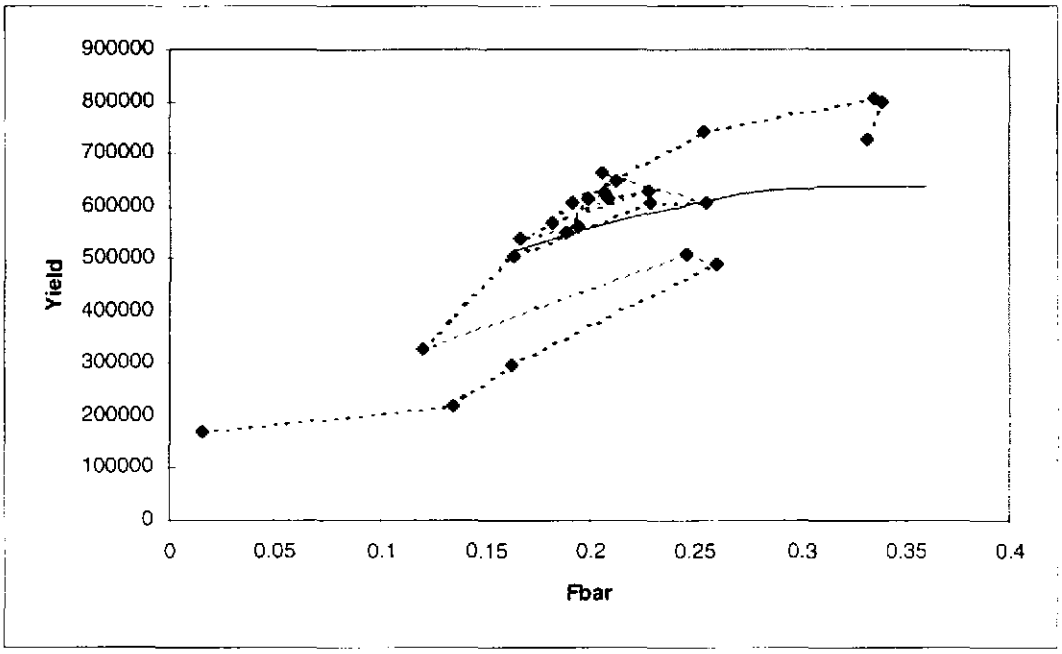


Figure 2.14.5 Plot of the time series of stock and recruitment with expected recruits based on the LOWESS stock recruitment relationship for Western mackerel.

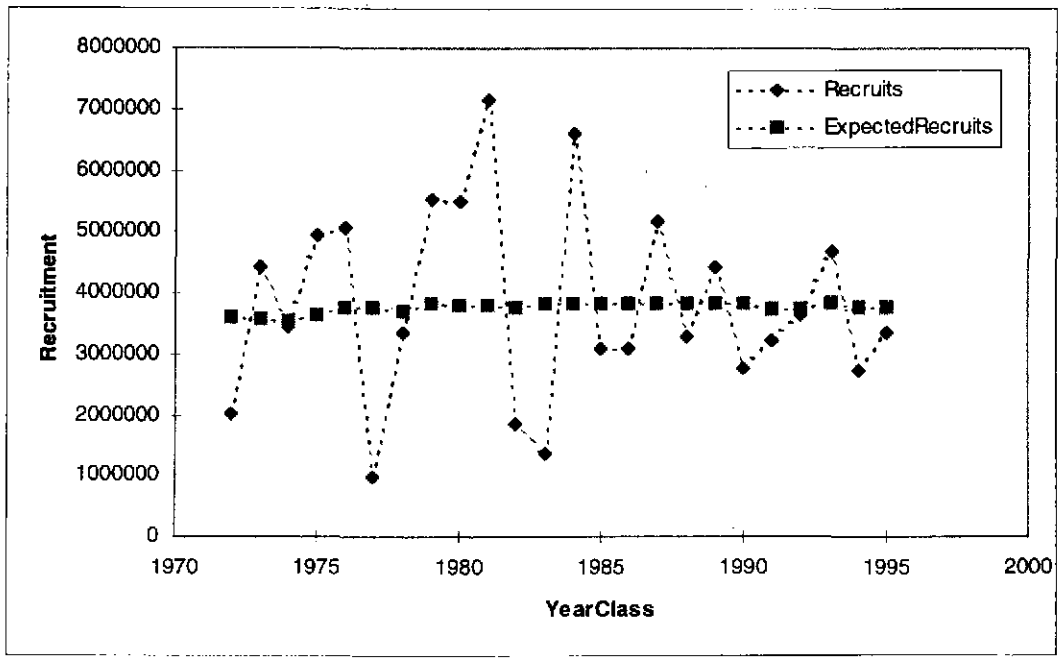
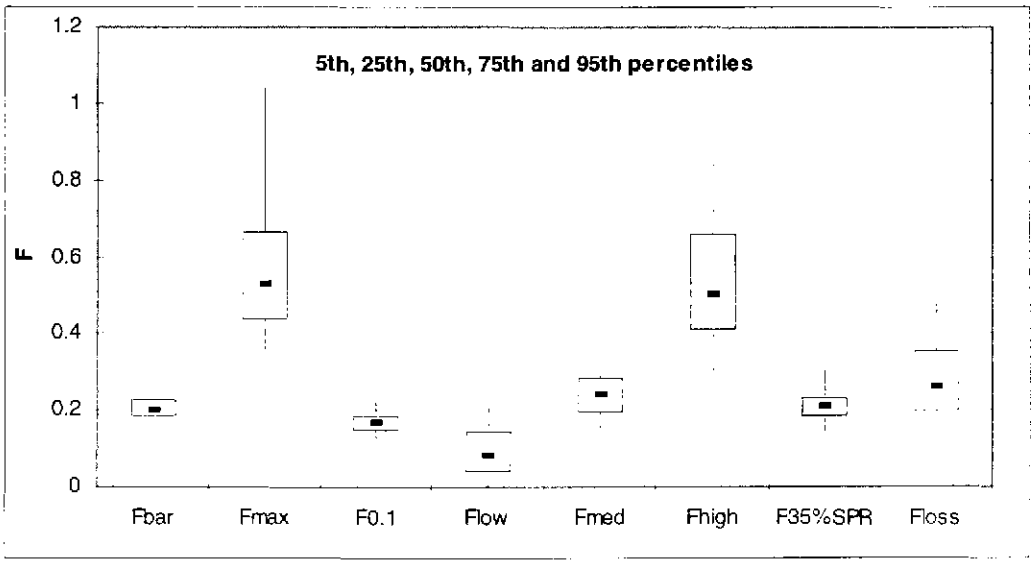


Figure 2.14.6 Various Reference points calculated for Western mackerel.



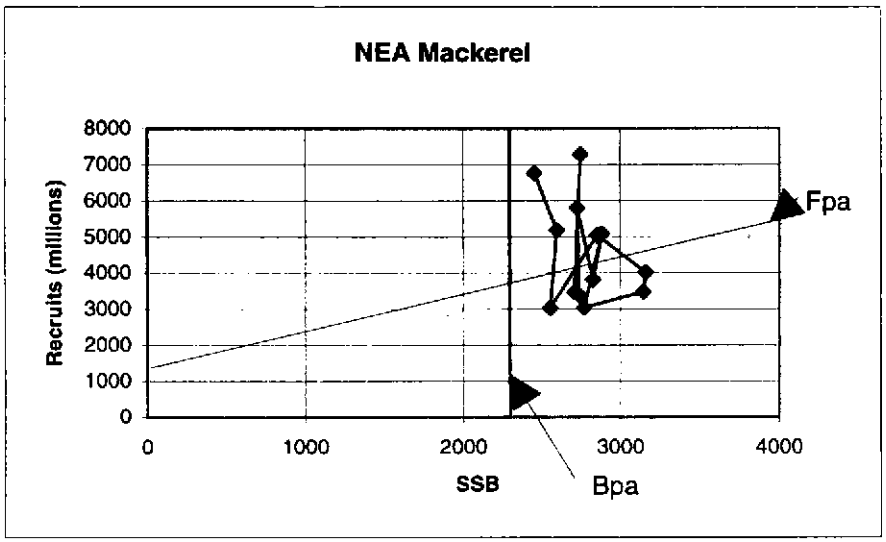


Figure 2.16.1
NEA Mackerel: Development of SSB and recruitment in relation to precautionary reference points

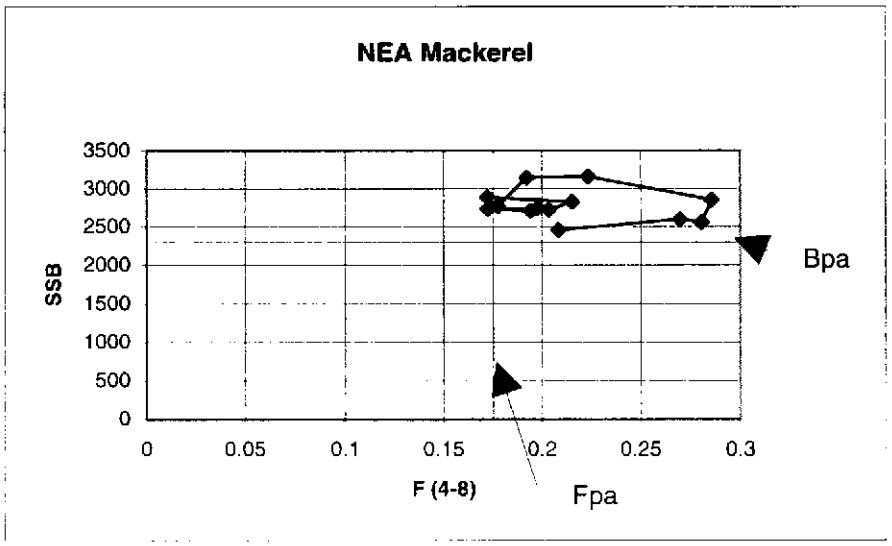


Figure 2.16.2
NEA Mackerel: Development of Fishing mortality and SSB in relation to precautionary reference points

3 MACKEREL STOCK COMPONENTS: NORTH SEA, WESTERN AND SOUTHERN AREAS

3.1 North Sea Mackerel

3.1.1 Biological data

The Western and Southern mackerel are mixing with the North Sea mackerel during the main fishing season. It is impossible to split the catches by the different components in the area where North Sea mackerel is distributed, Sub-area IV and Divisions IIa and IIIa. Catches of North Sea mackerel are included in the data for both North East Atlantic mackerel (Section 2) and western mackerel (Section 3.2). Since the SSB in the North Sea is only about 4% of that of North-East Atlantic mackerel, the catch of North Sea mackerel is assumed to be low. For multispecies assessment purposes this catch has for several years been assumed to be 10,000 t (see Sections 12.1.1–12.1.3).

3.1.2 Fishery independent information

3.1.2.1 Egg surveys

An egg survey of the North Sea was carried out in 1996, the first since 1990. Temporal and spatial coverage was poor compared with that of 1990, because only three surveys of the spawning area were carried out in 1996. The limited coverage resulted in some production areas being missed on the first survey. The SSB was estimated at 84,000 t. Using a mean atresia correction of 11.6%, from the western area, increases the estimate of SSB to 110,000 t (ICES 1997/H:4).

New egg surveys are planned for 1999, tentatively 24 May–28 June, by the Netherlands and Norway.

3.1.2.2 Trawl surveys

For the first time in several years relatively large quantities of juvenile mackerel were observed in the North Sea and Skagerrak during the autumn 1996 (0-group) and in 1997 (1-group). The abundance index of the 1996 year class as calculated from the North Sea International Young Fish Survey, first quarter of 1997, was very high (ICES 1998/Assess:6).This year class was not observed in the North Sea during the IBTS survey in the first quarter of 1998, but one year old mackerel (1997 year class) was observed during this survey (Figure 2.7.2.4), but not in the same quantities as the 1996 year class in the 1997 survey.

3.1.3 State of the stock

The estimated SSB from the egg surveys in 1996 was 110,000 t. Based on the egg surveys in 1990 the SSB was estimated at 78,000 t. This estimate was not adjusted for atresia and it is similar to the unadjusted estimate in 1996 of 84,000 t. The Working Group therefore still considers the North Sea mackerel to be severely depleted.

3.1.4 Management measures and considerations

The North Sea mackerel still needs maximum protection until the spawning stock shows evidence of recovery, while at the same time allowing fishing on the western and southern mackerel.

ACFM has for several years recommended the closure of Division IVa for fishing during the first half of the year until the Western Mackerel stock enters the North Sea in July–early August. This fish stays there until late December or January the following year before migrating back to the spawning areas. The implemented restrictions for fishing in the North Sea have particularly during the first quarter resulted in large-scale misreporting from the Northern part of the North Sea (Division IVa) to Division VIa. To allow a fishery during the first quarter might solve the misreporting problem. This would have implications for North Sea mackerel which traditionally have overwintered partly in this area. However, the percentage of North Sea mackerel in this area during this quarter is uncertain.

The Working Group endorses the recommendations made by ACFM for several years:

- There should be no fishing for mackerel in Divisions IIIa and IVb,c at any time of the year;
- There should be no fishing for mackerel in Division IVa during the period 1 January–31 July;
- The 30 cm minimum landing size at present in force in Sub-area IV should be maintained.

The closure of the mackerel fishery in Divisions IVb,c and IIIa the whole year will protect the North Sea stock in this area and the juvenile Western fish which are numerous particularly in Division IVb,c during the second half of the year. This closure has unfortunately resulted in increased discards of mackerel in the non-directed fisheries in this area as vessels at present are permitted to take only 10% of their catch as by-catch mackerel. No data on the actual size of mackerel by-catch have been available for the Working Group concerning 1997 but the reported landings of mackerel in Divisions IIIa and IVb,c for 1997 might be seriously under-estimated due to discarded by-catch.

3.2 Western Mackerel

3.2.1.1 Catch numbers at age

The 1997 catches in numbers at age by quarter for Western mackerel (Areas II, III, IV, V, VI, VII and Divisions VIIIa and VIIIb) are shown in Table 3.2.1.1.

The age structure of the catches of Western mackerel is predominantly 1–6 year old fish. The 1993 year class (4 year old fish) dominated the catches. Fish belonging to the 1996 year class were dominant in the catches in Q3 Division VIa. In other areas the catches were dominated by young fish; in IVb, IVc and VIIh catches were dominated by 1 year old fish; in VIId, and VIIe,f catches were dominated by 2 year olds; and VIIg catches were dominated by and 2 and 3 year old fish.

Age distributions of catches were provided by Denmark, England, Ireland, Netherlands, Norway, Russia, Scotland and Spain. There are still major gaps in the overall sampling for age from countries which take substantial catches, notably Faroes, France, Germany and Sweden (combined catch of 52,156 t). In addition there were no aged samples to cover the entire catch from VIIa, VIIg, VIIk and Va (total catch 528 t). As in 1997, catches for which there were no sampling data were converted into numbers at age using data from the most appropriate fleets. This is obviously undesirable where the only aged samples available are from a different type of gear.

Sampling data are further discussed in Section 1.4.1.

3.2.1.2 Mean lengths at age and mean weights at age

Mean lengths

The mean lengths at age per quarter for 1997 for Western mackerel are shown in Table 3.2.1.2. These data continue the long time series and are useful in investigating changes in relation to stock size (D. Skagen, WD).

Mean weights

The mean weights at age in the catches per quarter for 1997 for Western mackerel are shown in Table 3.2.1.3. The mean weights at age in the stock at spawning time for Western mackerel are given in Table 2.4.3.3. These data are based on samples from Dutch freezer trawlers (VIIb) and the Irish fleet (VIIb, VIIj), fishing on the spawning grounds during the period March to May 1997.

3.2.1.3 Maturity ogive

The assumptions about maturity made by the Working Group in previous years were retained, including the reduced maturity at age 2 of the 1984 year class agreed in 1997 (ICES 1998/Assess:6). Maturity at age is now assumed constant for each year of the assessment. The values are given in the text table below:

Age	0	1	2	3	4	5	6	7	8+
%	0	8	60	90	97	99	99	100	100

An estimation of the maturity ogive in 1998 will be obtained as part of the egg survey of the western area. In this context samples were taken over areas of predominantly juvenile distribution as well as on the spawning grounds The total number of samples taken is not yet available, but it seems likely that it will fall short of the ten targeted by the Planning Group (see Section 1.5.2). The samples will be analysed by histological examination to provide a more reliable estimate of the numbers of fish which will actually spawn in that year.

3.2.2 Fishery independent information

3.2.2.1 Egg surveys

Information on the historic time series of egg surveys which cover the area of the Western stock are given in Section 2.5.2. The scaling used to relate NE Atlantic egg survey estimates to the Western area is 0.85.

3.2.2.2 Trawl surveys

Bottom trawl surveys which provide information on Western stock juvenile mackerel include: Scottish surveys to the north and west of the British Isles in quarters 1 and 3, an English survey in the western approaches in quarter 1 and an Irish survey on the west coast of Ireland in quarter 4. Distribution of relevant data is given in Section 2.7.2. The index of recruitment derived from these surveys was not used in the assessment; reasons for this are given in Section 2.5.4. A Generalised Additive Model (GAM) was used to try and improve the performance of the recruitment index; details of this are given in Section 2.7.2. Data from these surveys continue to be the only source of information on the distribution of juvenile mackerel.

3.2.3 State of the stock

An assessment on Western mackerel was not carried out this year due to the reasons given in Section 2.9.1. Some data exploration with and without the preliminary 1998 egg survey estimate of biomass is presented in Section 2.9.1.

3.3 Southern Mackerel

3.3.1 Biological data

The catch in numbers, mean lengths and mean weights at age for Divisions VIII c and IX a are discussed in Section 2.4 (Tables 2.4.1, 2.4.2 and 2.4.3 - NEA mackerel).

Tables 3.3.1.1 and 3.3.1.2 show the total catch in numbers and mean weights at age for Southern mackerel (Divisions VIIIc and IXa) for 1984–1997.

Mean weights at age in the stock

The mean weights at age in the stock for the southern mackerel are based on samples obtained from the commercial catches during Quarter 1 and Quarter 4 as a mean over 1991 to 1995 (table below):

Stock Weights at Age (kg) for Southern Mackerel														
Age in Years														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
.161	.248	.305	.354	.385	.427	.455	.493	.511	.545	.548	.617	.622	656	.716

Maturity ogive

The assumption made about Southern mackerel maturity ogive is the same as in previous years (ICES 1997/Assess:3) (see text table below):

Maturity ogive of mackerel from southern area														
Age														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
.45	.89	.95	1	1	1	1	1	1	1	1	1	1	1	1

3.3.2 Fishery independent information and CPUE indices of stock size

3.3.2.1 Egg surveys

Data from mackerel egg surveys carried out in the Spanish and Portuguese waters during 1998 are at present not available. They will be presented to the Mackerel/Horse Mackerel Egg Survey Working Group.

3.3.2.2 Demersal trawl surveys

Table 3.3.2.2.1 shows the numbers at age per half hour trawl from the Spanish bottom trawl surveys from 1984 to 1997 in September–October and the numbers at age per hour trawl (*1000) from Portuguese bottom trawl autumn surveys from 1986 to 1997.

The two sets of autumn surveys covered Sub-divisions VIIIc East, VIIIc West and IXa North (Spain) from 20–500 m depth and Sub-divisions IXa Central North, Central South and South (Portugal), from 20–750 m depth. The same sampling methodology is used in both surveys but there are differences in the gear design.

3.3.3 Effort and catch per unit effort

This information is now given in Section 2.6.1.

Table 3.2.1.1 Catch numbers at age (000's) by quarter for Western mackerel in 1997.

Ages	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All Quarters
0	0	0	6,425	1,761	8,186
1	4,574	1,424	45,901	68,732	120,631
2	19,234	3,345	49,778	88,988	161,345
3	46,842	12,953	77,035	95,834	232,664
4	142,029	34,886	115,770	60,441	353,126
5	97,418	24,632	71,478	35,978	229,506
6	54,688	13,519	38,827	21,343	128,376
7	34,307	11,370	22,128	9,930	77,735
8	27,783	8,835	19,589	4,543	60,750
9	16,610	6,650	8,136	3,328	34,725
10	11,338	2,378	6,638	3,622	23,976
11	6,838	1,698	2,272	1,545	12,352
12	3,632	1,507	5,198	2,306	12,643
13	2,656	716	647	374	4,392
14	1,883	588	229	121	2,821
15+	1,966	394	516	147	3,022
SOP	178,270	45,116	183,382	125,498	532,285
Catch	178,334	45,107	180,776	124,617	528,834
SOP%	**100%**	**100%**	**99%**	**99%**	**99%**

Table 3.2.1.2 Mean length (cm) at age for Western Mackerel in 1997.

Ages	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All Quarters
0	0.0	0.0	21.6	23.0	21.9
1	25.1	23.2	26.9	27.6	27.2
2	29.2	29.0	30.4	31.7	31.0
3	32.0	32.3	32.8	32.9	32.7
4	34.7	34.4	34.9	35.2	34.8
5	36.3	36.5	36.2	36.8	36.4
6	37.2	37.4	37.2	37.3	37.2
7	38.6	39.3	37.9	38.0	38.4
8	39.5	39.4	39.0	38.5	39.3
9	40.3	40.6	39.5	40.3	40.2
10	40.7	41.2	39.7	40.2	40.4
11	41.4	41.5	40.8	40.2	41.2
12	41.8	41.1	41.3	41.7	41.5
13	41.2	41.8	41.7	40.4	41.3
14	41.6	43.6	43.0	42.0	42.2
15+	42.3	44.0	43.1	43.6	42.7

Table 3.2.1.3 Mean weight (kg) at age in the catch for Western mackerel in 1997.

Ages	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All Quarters
0	0.000	0.000	0.073	0.086	0.076
1	0.120	0.092	0.147	0.156	0.150
2	0.180	0.177	0.241	0.246	0.235
3	0.244	0.249	0.327	0.300	0.295
4	0.324	0.298	0.413	0.386	0.361
5	0.387	0.354	0.463	0.455	0.418
6	0.417	0.394	0.521	0.474	0.455
7	0.468	0.458	0.522	0.481	0.484
8	0.516	0.467	0.574	0.536	0.529
9	0.548	0.515	0.603	0.595	0.559
10	0.566	0.521	0.621	0.607	0.583
11	0.594	0.559	0.641	0.593	0.598
12	0.626	0.511	0.688	0.668	0.646
13	0.598	0.551	0.669	0.586	0.600
14	0.626	0.606	0.744	0.708	0.635
15+	0.655	0.650	0.776	0.697	0.677

Table 3.3.1.1 Catch numbers at age for the Southern Mackerel (Numbers * 10^-3).

AGE/YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	287887	81221	30419	4927	54829	40961	18896	5118	41728	6234	24899	11027	30858	28269
1	15285	30856	27323	16783	46960	21433	31935	11339	8634	13484	2876	7436	29026	27597
2	3788	3046	13324	8040	4347	5880	7518	9842	5372	7549	7650	5870	10551	22949
3	8599	1934	4862	10580	6652	4360	2662	11552	8889	2477	7949	9249	10077	7954
4	4679	10506	5402	4660	9719	4159	2876	12671	5482	10810	7920	6757	15307	26407
5	6475	3333	13251	9464	3220	6010	4683	6813	7813	4435	13126	5069	6300	17135
6	1643	2050	3727	7019	5588	2767	6615	4136	3430	8242	9425	7255	5041	6300
7	931	722	377	1707	12975	4106	1929	5609	2060	4352	6608	6907	9652	6807
8	1583	524	1522	1818	5610	5532	4718	1337	2908	2106	2899	6944	6187	5918
9	1540	1024	638	1082	1824	1581	5468	1405	868	2260	2735	3759	6172	4890
10	608	941	525	1626	543	819	1532	2899	1053	1424	1393	2611	2811	2780
11	732	775	198	917	291	334	697	523	1186	917	957	2226	2179	1609
12	348	528	3224	483	764	291	596	56	428	542	623	1243	939	1314
13	500	364	1714	461	716	292	58	111	195	643	275	644	208	347
14	360	313	0	115	125	85	137	79	14	279	336	642	251	184
15+	4	558	3237	241	940	346	145	361	68	1183	148	623	295	251
TOTAL	334962	138694	109745	69921	155105	98956	90465	73851	90128	66937	89819	78261	135853	160711
CATCH (t)	20308	18111	24789	22187	24773	18321	21312	20781	18046	19719	25045	27549	34121	38845

Table 3.3.1.2 Catch weights at age (kg) for the Southern Mackerel

AGE/YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	0.031	0.055	0.063	0.089	0.055	0.042	0.092	0.075	0.051	0.077	0.046	0.071	0.059	0.076
1	0.059	0.092	0.122	0.183	0.081	0.100	0.118	0.160	0.190	0.116	0.167	0.160	0.117	0.111
2	0.228	0.189	0.249	0.251	0.218	0.197	0.207	0.208	0.265	0.200	0.205	0.246	0.175	0.176
3	0.248	0.299	0.289	0.291	0.251	0.267	0.256	0.242	0.279	0.307	0.262	0.303	0.272	0.274
4	0.303	0.339	0.390	0.398	0.286	0.357	0.310	0.294	0.325	0.326	0.352	0.370	0.326	0.319
5	0.344	0.408	0.401	0.442	0.326	0.392	0.365	0.333	0.366	0.360	0.379	0.409	0.410	0.366
6	0.378	0.484	0.404	0.474	0.342	0.472	0.401	0.400	0.404	0.401	0.422	0.443	0.450	0.416
7	0.392	0.502	0.567	0.560	0.388	0.499	0.475	0.439	0.435	0.443	0.457	0.478	0.466	0.449
8	0.457	0.593	0.512	0.602	0.395	0.511	0.494	0.485	0.463	0.469	0.498	0.507	0.493	0.472
9	0.451	0.596	0.417	0.638	0.406	0.544	0.525	0.508	0.480	0.499	0.525	0.530	0.510	0.509
10	0.441	0.609	0.567	0.624	0.480	0.545	0.507	0.521	0.537	0.491	0.536	0.556	0.545	0.529
11	0.465	0.607	0.649	0.652	0.494	0.591	0.565	0.517	0.544	0.518	0.579	0.560	0.546	0.544
12	0.345	0.646	0.528	0.449	0.492	0.565	0.540	0.746	0.595	0.597	0.626	0.619	0.561	0.583
13	0.406	0.636	0.526	0.519	0.543	0.626	0.729	0.674	0.523	0.590	0.629	0.657	0.656	0.596
14	0.504	0.679	0.000	0.663	0.549	0.579	0.553	0.667	0.718	0.578	0.625	0.616	0.626	0.644
15+	0.708	0.667	0.679	0.769	0.567	0.735	0.724	0.720	0.708	0.744	0.722	0.675	0.663	0.664
0-15+	0.060	0.153	0.286	0.329	0.161	0.186	0.231	0.281	0.200	0.294	0.280	0.352	0.251	0.253

Table 3.3.2.2.1 SOUTHERN MACKEREL. CPUE at age from surveys.

October Spain Survey, Bottom trawl survey (Catch: numbers)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10+
1984	1	1.467	0.200	0.106	0.371	0.149	0.209	0.039	0.013	0.029	0.018	0.065
1985	1	2.653	1.598	0.016	0.055	0.370	0.138	0.085	0.030	0.017	0.029	0.084
1986	1	0.026	0.174	0.140	0.022	0.026	0.060	0.025	0.002	0.000	0.004	0.029
1987												
1988	1	0.286	0.028	0.027	0.014	0.021	0.005	0.010	0.012	0.004	0.001	0.001
1989	1	0.510	0.000	0.020	0.000	0.040	0.020	0.000	0.010	0.000	0.000	0.000
1990	1	0.400	0.940	0.040	0.000	0.010	0.020	0.000	0.000	0.000	0.000	0.000
1991	1	0.130	0.270	0.220	0.270	0.340	0.070	0.030	0.010	0.030	0.000	0.010
1992	1	19.900	0.480	0.160	0.150	0.090	0.030	0.010	0.000	0.000	0.000	0.000
1993	1	0.071	1.256	0.789	0.026	0.063	0.018	0.008	0.002	0.002	0.002	0.005
1994	1	0.468	0.106	0.122	0.145	0.043	0.040	0.012	0.006	0.002	0.001	0.000
1995	1	0.916	0.031	0.187	0.164	0.049	0.013	0.011	0.003	0.002	0.001	0.000
1996	1	46.092	6.396	1.316	0.074	0.101	0.019	0.000	0.007	0.010	0.000	0.000
1997	1	5.725	27.105	6.283	0.67	0.389	0.000	0.000	0.000	0.000	0.000	0.000

October Portugal Survey, Bottom trawl survey (Catch: number* 1000)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10+
1986	1	515	2759	1004	512	36	14	9	4	0	0	0
1987	1	1026	23280	14792	2939	545	0	0	0	0	0	0
1988	1	86467	24547	354	328	35	11	0	0	0	0	0
1989	1	11643	28427	4707	3452	22	9	0	0	0	0	0
1990	1	1344	2991	1753	89	5	1	0	0	0	0	0
1991	1	309	374	288	185	32	19	15	6	1	1	0
1992	1	123551	2738	664	302	57	14	5	0	0	0	0
1993	1	52323	385	115	47	75	0	0	0	0	0	0
1994	1	12211	771	297	106	42	49	18	14	0	0	0
1995	1	318598	9076	282	110	31	10	5	2	0	0	0
1996*	1	235262	2157	216	22	4	1	0	0	0	0	0
1997	1	772029	39402	7655	39	0	0	0	0	0	0	0

* DIFFERENT SHIP

4 HORSE MACKEREL

4.1 Fisheries in 1997

The total international catches of horse mackerel in the North East Atlantic are shown in Table 4.1.1 and Figure 4.3.1. The total catch from all areas in 1997 was 519,000 t which is 60,000 t more than in 1996 and the second highest on record. Ireland, Denmark and the Netherlands have a directed trawl fishery and Norway a directed purse seine fishery for horse mackerel. Spain and Portugal have a directed trawl and purse seine fishery.

The quarterly catches of horse mackerel by Division and Sub-division in 1997 are given in Table 4.1.2. The distribution of the fisheries in 1997 are given in Figure 4.1.1.a–d. The figures are based on data provided by Denmark, England and Wales, Germany, Ireland, the Netherlands, Norway, Portugal and Spain covering 80% of the total catches.

First quarter: 176,500 t. This is 13,000 t more than 1996. The catches this quarter (Figure 4.1.1.a) are distributed in the western and southern areas as in previous years, while hardly any catches were taken in the Scotland-Shetland area this year.

Second quarter: 76,000 t. This is 18,000 t more than in 1996. As usual, rather low catches were taken during the second quarter and the catches are distributed as in previous years (Figure 4.1.1.b).

Third quarter: 86,000 t. This is the same catch level as in 1996, and the catches were distributed as in previous years (Figure 4.1.1.c).

Fourth quarter: 180,500 t. This is the quarter when relatively large catches have been taken in Division IVa since 1987. The catches in this quarter were reduced from 260,000 t in 1995 to 153,000 t in 1996. This was particularly due to a drop in the fishery in Division IVa. In 1997 the fishery increased in this Division by about 30,000 t (see Section 6.13). The catches were distributed as in previous years (Figure 4.1.1.d).

4.2 Stock Units

The last 9 years the Working Group has considered the horse mackerel in the north east Atlantic as separated into three management stocks: the North Sea, The Southern and the Western stocks (ICES 1990/Assess:24, ICES 1991/Assess:22). Since little information from research surveys is available, this separation is based on the observed egg distributions and the temporal and spatial distribution of the fishery. Western horse mackerel are thought to have similar migration patterns as Western mackerel. As for mackerel, the egg surveys have demonstrated that it is difficult to determine a realistic border between a western and southern spawning area. In later years some horse mackerel have been tagged in Portuguese and Spanish waters, but so far no tags have been recovered.

4.3 Allocation of Catches to Stocks

There is no information available about when and where the catches reported from Division IIIa were taken. Usually most of these catches have been taken in the western part of the Division in third and fourth quarter which is closer to the catch distributions in Division IVa than in Divisions IVb,c both spatially and temporally.

In 1997, 2,617 t were reported as landed from Division IIIa and these catches were assumed taken from the western part of the Division during the third and fourth quarter and thereby allocated to the western stock. During the fourth quarter the Norwegian fishery extended from Division IVa into the northern part of Division IVb where 1,426 t were taken. These catches were also allocated to the western stock. Except for these catches, the catches in 1997 were as in previous years allocated to the different stocks as:

Western stock: Divisions IIa, IIIa (western part), Vb, IVa, VIa, VIIa–c,e–k and VIIIa,b,d,e.

North Sea stock: Divisions IIIa (eastern part), IVb,c and VIId.

Southern stock: Divisions VIIIc and IXa

The catches by stock are given in Table 4.3.1 and Figure 4.3.1. Only one country provides data for discards. Therefore the amount of discards given in Table 4.3.1 are not representative for the total fishery.

At present there is only set a TAC for the western stock. However, this TAC only applies to EU waters. The present management area for this stock is therefore Divisions VIa, VIIa–c,e–k and VIIIa,b,d,e and western part of Division IVa,

which do not cover the total distribution area. If TACs are set by stocks, they should apply to all areas where the different stocks are distributed:

Western stock: Divisions IIa, IIIa (western part), Vb, IVa, VIa, VIIa–c,e–k and VIIIa,b,d,e.

North Sea stock: Divisions IIIa (eastern part), IVb,c and VIId.

Southern stock: Divisions VIIIc and IXa.

4.4 Estimates of Discards

At present only one country - the Netherlands - is providing information on discards but this information is not applied to any other fleets.

Information on discarding by the Dutch fleet is obtained from part (15–20%) of the pelagic fleet which is regarded to be representative for all areas and months where the pelagic fleet is operating (see also Section 1.7 on fleet description). Estimates on discards are not made by independent observers of the fishery activities, but the crew collects information during each trip per haul concerning date, position, trawl duration, catch composition by species. This estimation of the catch of each haul is done at the time the catch is taken on board (before any discarding takes place). If a catch is lost by torn nets, it is also reported. The information on species composition of the catch is added later. Finally the information on discards is obtained by comparing catch and actual reported landings. This discard information by species is then applied to only the whole Dutch pelagic fleet by month and by ICES Division, but not to the international fleet. This report contains a number of tables in which catches and discards are reported on an annual basis, but not on a quarterly basis (however, the basic discard data are available by month and by ICES Division). General information on discards in the pelagic fleets is provided in Section 1.4.3.

4.5 Species Mixing

***Trachurus* sp.**

Three species of *Trachurus* genus, *T. trachurus*, *T. mediterraneus* and *T. picturatus* are found together in the north east Atlantic waters and are commercially exploited in parts of the Sub-area VIII and Division IXa. Studies on genetic differentiation showed three clear groups corresponding to each species of *Trachurus* with no intermediate principal component scores, excluding the possibility of hybrids between species (Soriano, M. and Sanjuan, WD 1997).

Following the Working Group recommendation (ICES 1998/Assess:6), special care was again taken to ensure that catch and length distributions and numbers at age of *T. trachurus* supplied to the Working Group did not include *T. mediterraneus* and *T. picturatus*. Spain provided data on *T. mediterraneus* and Portugal on *T. picturatus*.

Table 4.5.1 shows the catch of *T. mediterraneus* by Sub-divisions since 1989. In Divisions VIIIa,b and Sub-division VIIIc East , the total catch of *T. mediterraneus* was 3,822 t in 1997. In Sub-division VIIIc West and Division IXa North there are no catches of this species.

As in previous years in both areas, more than 95% of the catches were obtained by purse seiners and the main catches were taken in the second half of the year, mainly in autumn, when the *T. trachurus* catches were lowest. *T. mediterraneus* catches were lowest in spring.

Catches and length distributions of *T. mediterraneus* in the Spanish fishery in Divisions VIIIa,b and c were reported separately from the catches and length distributions of *T. trachurus*. Data of monthly landings by gear and area were obtained from fishing vessel owner's associations and fishermen's associations through the existing information network of the IEO and AZTI (Advisory Organisations to Fisheries and Oceanography Administration) in all ports of the Cantabrian and Galician ports. *T. mediterraneus* is only landed in ports of the Basque country, Cantabria and Asturias. In ports of the Basque country the catches of *T. mediterraneus* and *T. trachurus* appear separately, except some small categories, in which the separation is made on the basis of samplings carried out in ports and information reported by fishermen. In the ports of Cantabria and Asturias the separation of the catch of the two species is not registered in all the ports, for which reason the total separation of the catch is made based on the monthly percentages of the ports in which these catches are separated and based on samplings made in the ports of this area.

A fishery for *T. picturatus* only occurred in the southern part of Division IXa, as in previous years. Data on *T. picturatus* in the Portuguese fishery for the period 1986–1997 are also given in Table 4. 5.1. Catches and length distributions of *T. trachurus* for the Portuguese fishery in Division IXa do not include data for *T. picturatus*. Landings data are collected

from the auction market system and sent to the General Directorate for Fisheries to be compiled. This includes information on landings per species by day and vessel.

As information is available on the amounts and distribution of catches of *T. mediterraneus* and *T. picturatus* for at least nine years (ICES 1990/Assess:24, ICES 1991/Assess:22, ICES 1992/Assess:17, ICES 1993/Assess:19, ICES 1995/Assess:2, ICES 1996/Assess:7, ICES 1997/Assess:3, and ICES 1998/Assess:6), and as the evaluations and assessments are only made for *T. trachurus*, the Working Group recommends that the TACs and any other management regulations which might be established in the future should be related only to *T. trachurus* and not to *T. trachurus* spp. in general, as is the case at present. It would then be appropriate to set TACs for the other species as well.

4.6 Length Distribution by Fleet and by Country

The 1997 annual length composition by fleet were provided by the Denmark, Netherlands, Norway, Portugal and Spain. These length distributions cover 75% of the total landings and are shown in Table 4.6.1.

Table 4.1.1 Landings (t) of HORSE MACKEREL by Sub-area. Data as submitted by Working Group members.

Sub-area	1979	1980	1981	1982	1983	1984
II	2	-	+	-	412	23
IV + IIIa	1,412	2,151	7,245	2,788	4,420	25,987
VI	7,791	8,724	11,134	6,283	24,881	31,716
VII	43,525	45,697	34,749	33,478	40,526	42,952
VIII	47,155	37,495	40,073	22,683	28,223	25,629
IX	37,619	36,903	35,873	39,726	48,733	23,178
Total	137,504	130,970	129,074	104,958	147,195	149,485

Sub-area	1985	1986	1987	1988	1989	1990
II	79	214	3,311	6,818	4,809	11,414
IV + IIIa	24,238	20,746	20,895	62,892	112,047	145,062
VI	33,025	20,455	35,157	45,842	34,870	20,904
VII	39,034	77,628	100,734	90,253	138,890	192,196
VIII	27,740	43,405	37,703	34,177	38,686	46,302
IX	20,237	31,159	24,540	29,763	29,231	24,023
Total	144,353	193,607	222,340	269,745	358,533	439,901

Sub-area	1991	1992	1993	1994	1995	1996	1997[1]
II + Vb	4,487	13,457	3,168	759	13,133	3,366	2,617
IV + IIIa	77,994	113,141	140,383	112,580	98,745	27,782	81,198
VI	34,455	40,921	53,822	69,616	83,595	81,259	40,145
VII	201,326	188,135	221,120	200,256	330,705	279,109	326,415
VIII	49,426	54,186	53,753	35,500	28,709	48,269	40,806
IX	21,778	26,713	31,944	28,442	25,147	20,400	27,642
Total	389,466	436,553	504,190	447,153	580,034	460,185	518,882

[1]Preliminary.

Table 4.1.2 Quarterly catches of HORSE MACKEREL by Division and Sub-division in 1997.

Division	1Q	2Q	3Q	4Q	TOTAL
IIa+Vb	0	0	678	1939	2617
IIIa	0	0	205	1832	2037
IVa	364	1274	2454	59555	63647
IVbc	73	3	5377	10061	15514
VIId	29	12	21	5390	5452
VIa	14184	2452	13577	9932	40145
VIIa–c,e–k	145906	53182	43102	78832	321022
VIIIa,b,d,e	4796	2845	2237	1799	11677
VIIIc	5019	8955	8743	6412	29129
IXa	6068	7548	9329	4697	27642
Sum	176439	76271	85723	180449	518882

Table 4.3.1 Landings and discards of HORSE MACKEREL (t) by year and division, for the North Sea, Western and Southern horse mackerel. (Data submitted by Working Group members.)

Year	North Sea horse mackerel						Western horse mackerel							Southern horse mackerel			Total
	IIIa		IVb,c	Discards	VIId	Total	IIa	IVa	VIa	VIIa-c,e-k	VIIIa,b,d,e	Discards	Total	VIIIc	IXa	Total	All stocks
1982	-	2,788[3]	-		1,247	4,035	-	-	6,283	32,231	3,073	-	41,587	19,610	39,726	59,336	104,958
1983	-	4,420[3]	-		3,600	8,020	412	-	24,881	36,926	2,643	-	64,862	25,580	48,733	74,313	147,195
1984	-	25,893[3]	-		3,585	29,478	23	94	31,716	38,782	2,510	500	73,625	23,119	23,178	46,297	149,400
1985	1,138		22,897		2,715	26,750	79	203	33,025	35,296	4,448	7,500	80,551	23,292	20,237	43,529	150,830
1986	396		19,496		4,756	24,648	214	776	20,343	72,761	3,071	8,500	105,665	40,334	31,159	71,493	201,806
1987	436		9,477		1,721	11,634	3,311	11,185	35,197	99,942	7,605	-	157,240	30,098	24,540	54,638	223,512
1988	2,261		18,290		3,120	23,671	6,818	42,174	45,842	81,978	7,548	3,740	188,100	26,629	29,763	56,392	268,163
1989	913		25,830		6,522	33,265	4,809	85,304[2]	34,870	131,218	11,516	1,150	268,867	27,170	29,231	56,401	358,533
1990	14,872[1]		17,437		1,325	18,762	11,414	112,753[2]	20,794	182,580	21,120	9,930	373,463	25,182	24,023	49,205	441,430
1991	2,725[1]		11,400		600	12,000	4,487	63,869[2]	34,415	196,926	25,693	5,440	333,555	23,733	21,778	45,511	391,066
1992	2,374[1]		13,955	400	688	15,043	13,457	101,752	40,881	180,937	29,329	1,820	370,550	24,243	26,713	50,955	436,548
1993	850[1]		3,895	930	8,792	13,617	3,168	134,908	53,782	204,318	27,519	8,600	433,145	25,483	31,945	57,428	504,190
1994	2,492[1]		2,496	630	2,503	5,689	759	106,911	69,546	194,188	11,044	3,935	388,875	24,147	28,442	52,589	447,153
1995	240		7,948	30	8,666	16,756	13,133	90,527	83,486	320,102	1,175	2,046	510,597	27,534	25,147	52,681	580,034
1996	1,657		7,558	212	9,416	18,843	3,366	18,356	81,259	252,823	23,978	16,870	396,652	24,290	20,400	44,690	460,185
1997	2,037[4]		15,504[5]	10	5,452	19,540	2,617	63,647	40,145	318,101	11,677	2,921	442,571	29,129	27,642	56,771	518,882

[1]Norwegian and Danish catches are included in the Western horse mackerel.
[2]Norwegian catches in Division IVb included in the Western horse mackerel.
[3]Divisions IIIa and IVb,c combined.
[4]Included in Western horse mackerel (Danish and Swedish catches).
[5]Norwegian catches in IVb (1,426 t) included in Western horse mackerel.

Table 4.5.1 Catches (t) of *Trachurus mediterraneus* in Divisions VIIIab, VIIIc and IXa in the period 1989-1997 and *Trachurus picturatus* in Division IXa, Sub-area X and in CECAF Division 34.1.1 in the period 1986-1997.

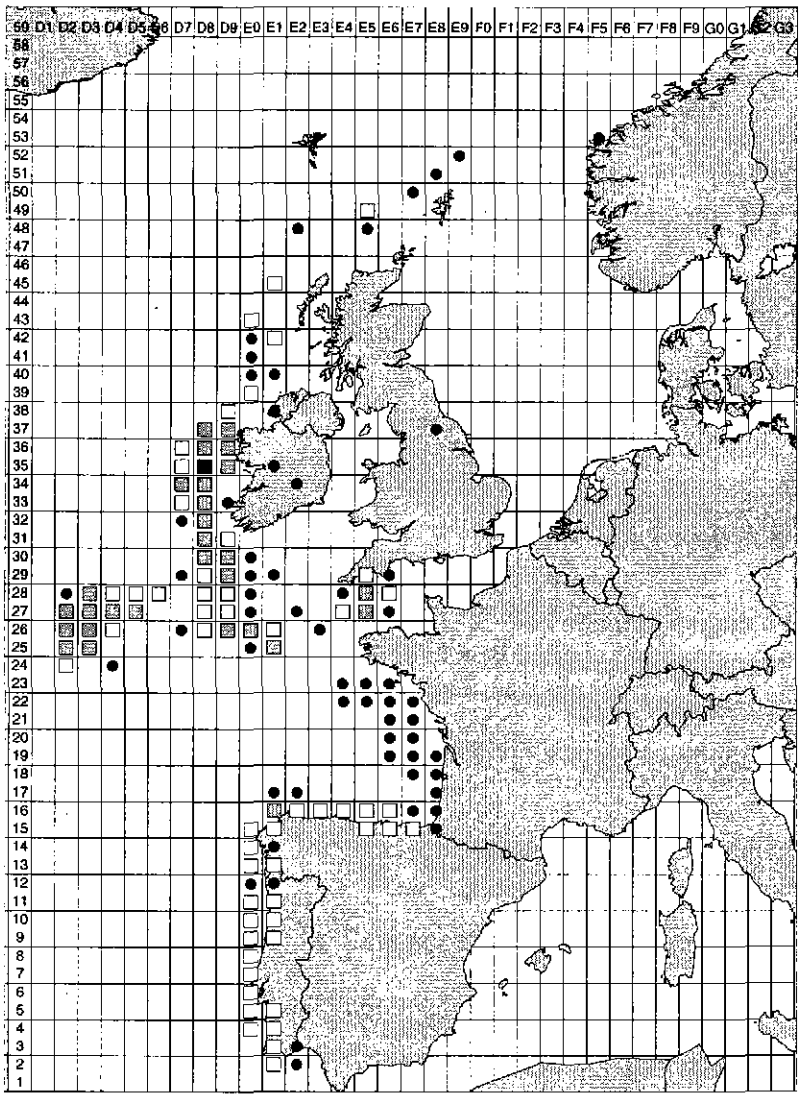
	Divisions	Sub-Divisions	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
T. mediterraneus	**VIIIab**		-	-	-	23	298	2122	1123	649	1573	2271	1175	557
	VIIIc	VIIIc East	-	-	-	3903	2943	5020	4804	5576	3344	4585	3443	3264
		VIIIc west	-	-	-	0	0	0	0	0	0	0	0	0
		Total	-	-	-	3903	2943	5020	4804	5576	3344	4585	3443	3264
	IXa	IXa North	-	-	-	0	0	0	0	0	0	0	0	0
		IXa C, N & S	-	-	-	0	0	0	0	0	0	0	0	0
		Total	-	-	-	0	0	0	0	0	0	0	0	0
T. picturatus	**IXa**		367	181	2370	2394	2012	1700	1035	1028	1045	728	1009	834
	X Azorean Area		3331	3020	3079	2866	2510	1274	1255	1732	1778	1822	1715	1920
	34.1.1 Madeira's area		2006	1533	1687	1564	1863	1161	792	530	297	206	393	762

(-) Not available

Table 4.6.1 Length distributions (%) of HORSE MACKEREL catches by fleet and country in 1997.

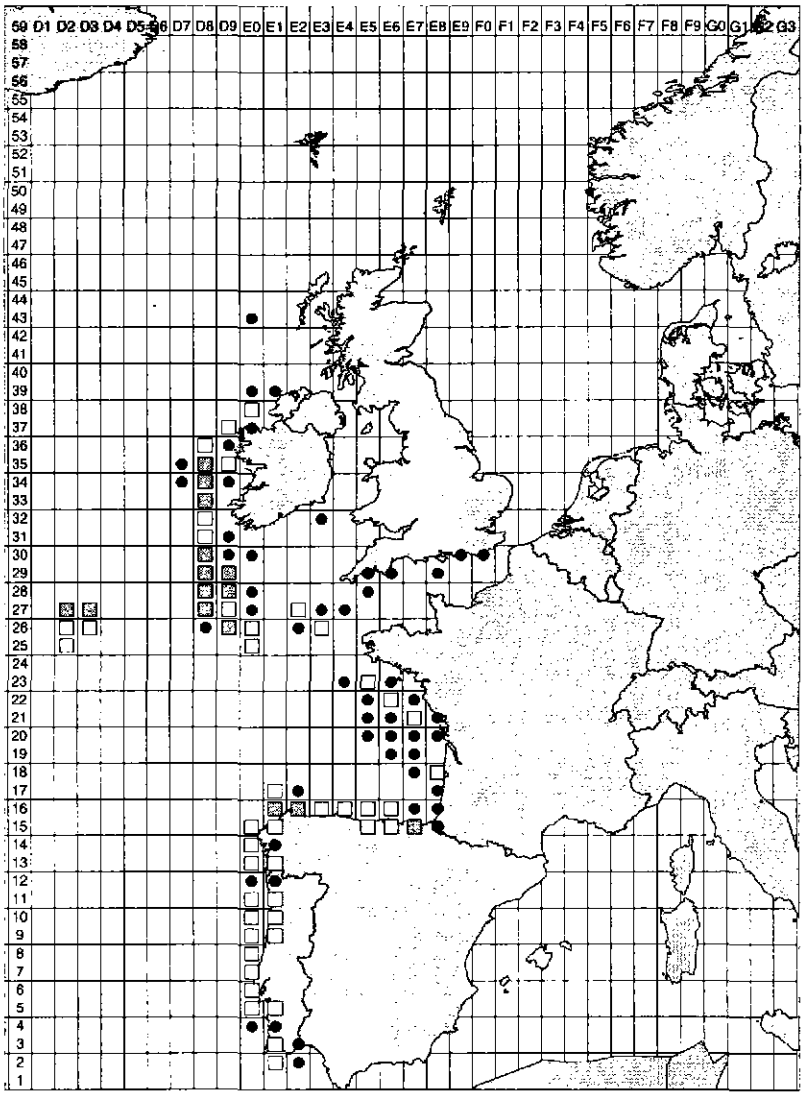
	Denmark	Netherlands	Norway		Spain				Portugal		Ireland
		Pel.trawl	P.seine	P.sene	Dem.trawl	Gill net	Hook	Artisan	trawl	P.sene	Pel.trawl
cm											
5	0.01										
6	0.68										
7	0.93										
8	1.86			0.01	0.43						
9	2.24			0.04	1.35						
10	2.68			0.55	2.37				0.01	0.01	
11	1.43			4.42	0.98			0.09	0.61	0.37	
12	1.43			8.51	1.08			0.70	4.68	3.52	
13	0.54			5.79	2.39			3.39	11.20	24.93	
14	0.17			3.79	4.28			3.65	14.30	21.40	
15	0.02			3.96	6.77			1.04	15.52	6.64	
16	0.04			5.53	7.37			1.22	15.03	9.58	
17	1.51	0.06		6.49	4.77			2.09	11.58	12.07	
18	8.96	0.64		9.44	2.78	0.00		3.56	9.52	12.18	
19	17.71	0.70		7.22	1.08	0.00		2.95	6.46	3.73	
20	12.50	0.78		6.23	1.06	0.00		1.65	2.86	0.65	
21	11.90	5.21	0.05	3.81	0.66	1.69	1.22	0.70	0.95	0.20	
22	7.57	11.52		2.91	0.53	1.69	3.66	1.22	1.27	1.17	0.15
23	5.98	12.99		3.27	0.94	1.69	2.44	4.08	1.77	1.57	0.97
24	4.60	13.06		3.76	1.94	1.69	4.88	7.04	1.34	1.16	7.37
25	3.52	9.58	0.05	3.98	3.77	3.39	8.54	8.34	0.92	0.40	17.60
26	3.44	6.18	0.22	3.36	6.26	6.78	7.32	10.60	0.55	0.13	18.40
27	5.06	7.07	1.93	3.44	8.49	10.17	10.98	10.25	0.42	0.10	12.39
28	1.06	6.85	4.62	3.24	7.61	10.17	9.76	7.73	0.31	0.05	11.55
29	3.09	6.36	10.11	3.19	6.79	10.17	9.76	5.04	0.17	0.05	10.12
30	0.37	6.79	13.58	2.16	5.55	8.47	7.32	4.60	0.12		6.84
31	0.13	4.48	15.61	1.64	4.99	6.78	10.98	2.87	0.07	0.05	4.17
32	0.13	1.97	15.83	1.09	4.42	6.78	3.66	2.78	0.04	0.03	2.95
33	0.07	1.90	12.76	0.72	3.30	5.08	4.88	2.61	0.04		3.46
34	0.18	1.55	12.04	0.51	2.13	5.08	3.66	2.43	0.05		2.14
35		1.23	7.75	0.29	1.78	3.39	3.66	2.35	0.07		0.84
36	0.13	0.66	3.63	0.18	1.04	3.39	4.88	1.91	0.04		0.65
37		0.36	1.21	0.13	1.23	3.39	1.22	1.48	0.04		0.28
38		0.04	0.50	0.07	0.84	3.39	1.22	0.87	0.02		0.09
39		0.02	0.11	0.10	0.70	3.39	0.00	0.70	0.02		
40	0.06	0.00		0.08	0.35	1.69	0.00	0.78	0.01		0.01
41				0.04		1.69	0.00	0.61	0.00		
42+				0.05		0.00		0.70	0.00		
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
0.00=<0.005%											

Figure 4.1.1.a Distribution of horse mackerel catches Quarter 1 1997.



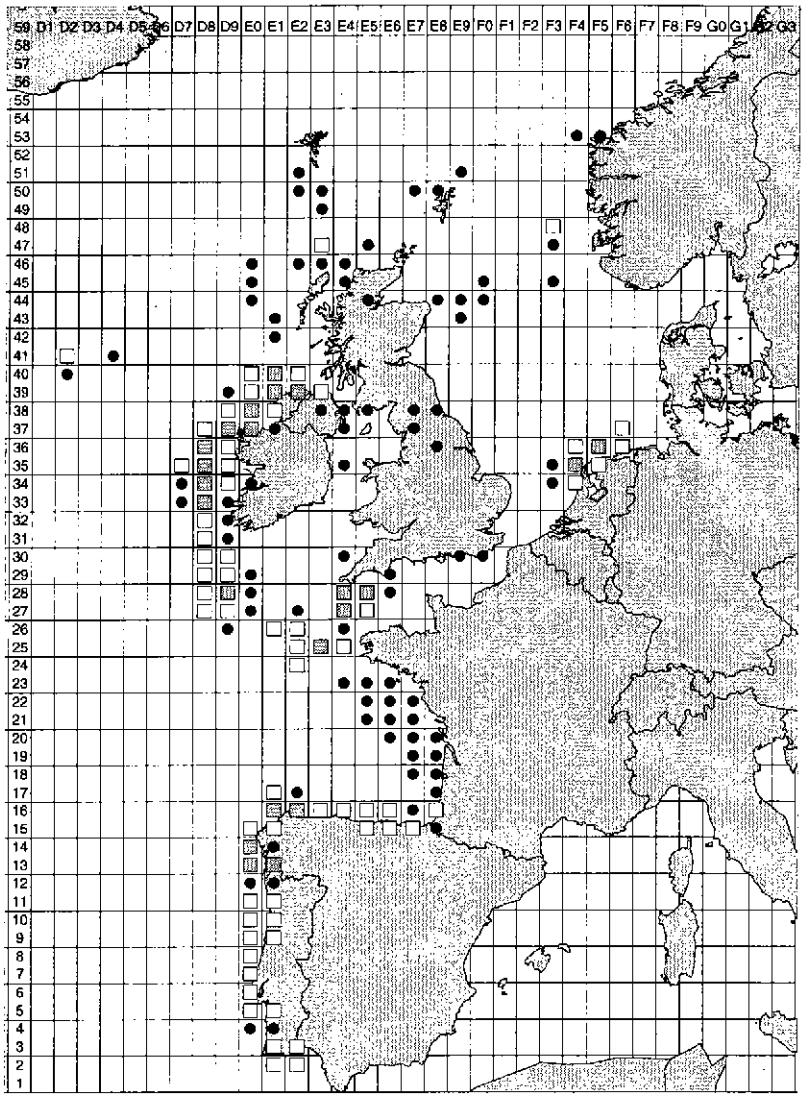
■ > 10,000 tonnes
▒ 1,000 to 10, 000 tonnes
□ 100 to 1,000 tonnes
• < 100 tonnes

Figure 4.1.1.b Distribution of horse mackerel catches Quarter 2 1997.



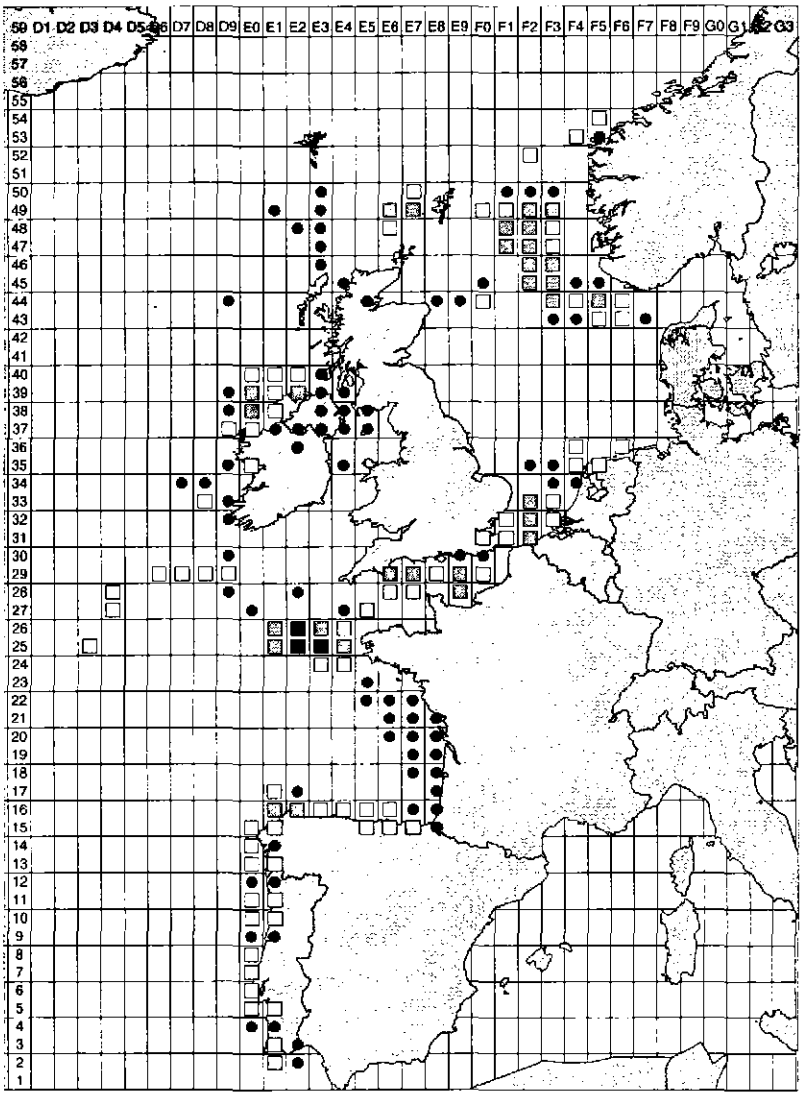
■ > 10,000 tonnes
▩ 1,000 to 10, 000 tonnes
□ 100 to 1,000 tonnes
• < 100 tonnes

Figure 4.1.1.c Distribution of horse mackerel catches Quarter 3 1997.



■ > 10,000 tonnes
▩ 1,000 to 10, 000 tonnes
□ 100 to 1,000 tonnes
• < 100 tonnes

Figure 4.1.1.d Distribution of horse mackerel catches Quarter 4 1997.



■ > 10,000 tonnes
■ 1,000 to 10, 000 tonnes
□ 100 to 1,000 tonnes
• < 100 tonnes

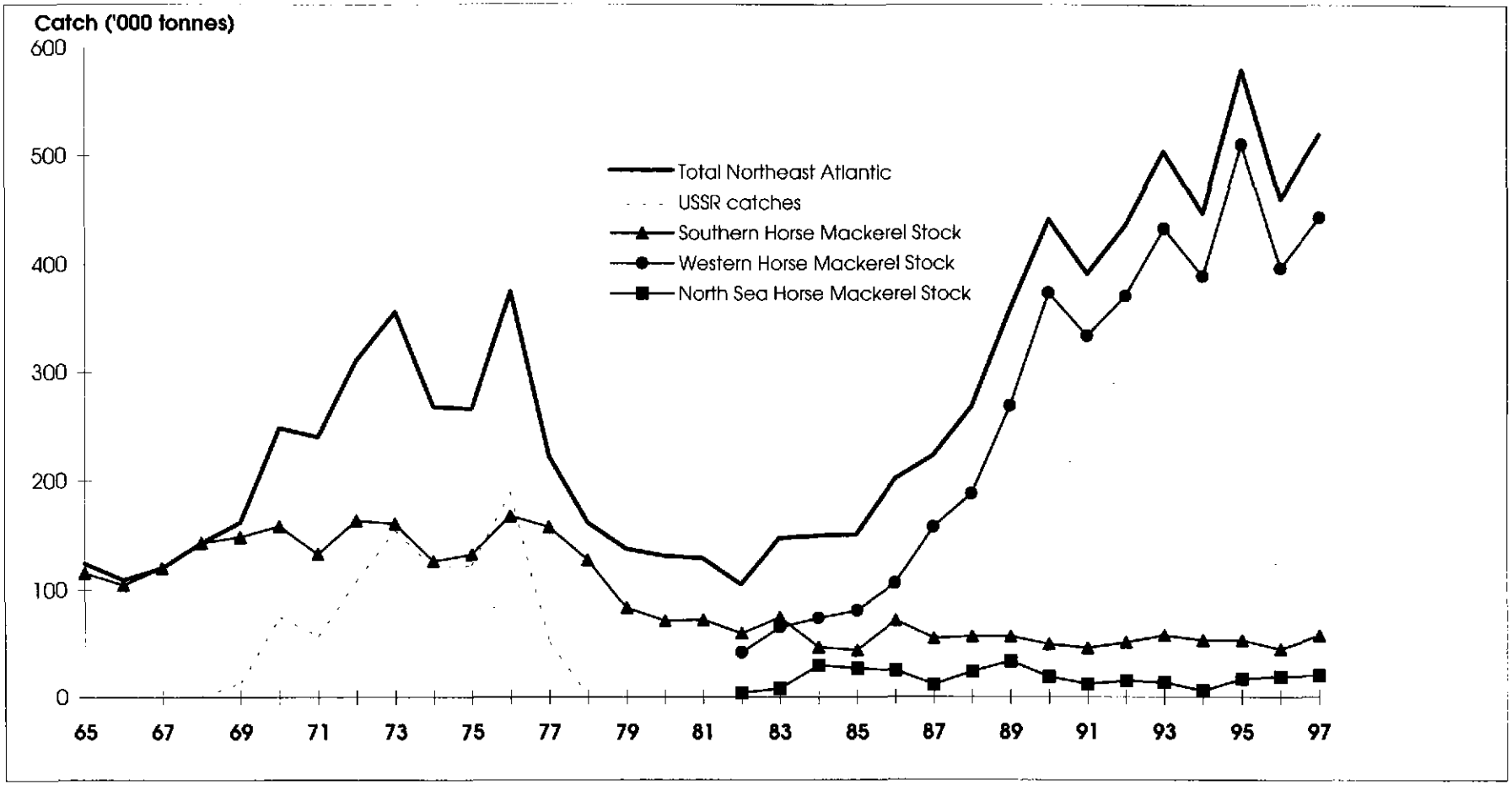


Figure 4.3.1 Total catches of horse mackerel in the northeast Atlantic during the period 1965 - 1997. The catches taken by the USSR and catches taken from the southern, western and North Sea horse mackerel stocks are shown in relation to the total catches in the northeast Atlantic.

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5 NORTH SEA HORSE MACKEREL (DIVISIONS IIIa - EXCEPT WESTERN PART OF SKAGERRAK IVb,c AND VIId)

5.1 ACFM Advice Applicable to 1997 and 1998

As usual, no TAC advice was given. The agreed TAC has been fixed at 60,000 t since 1993 and the catches have varied between 6,500 t and 19,500 t in the same period. In May 1998 ICES recommended that consistent with a precautionary approach a management plan including monitoring of the development of the stock and fishery with corresponding intervention rules should be developed and implemented.

5.2 The Fishery

The total catch taken from the North Sea and Division IIIa dropped from a level of 100,000 t–140,000 t during the period 1992–1995 to 28,000 t in 1996 and increased to about 80,000 t in 1997.

Usually catches taken in Divisions IIIa - except western part of Skagerrak - IVb,c and VIId are regarded as belonging to the North Sea horse mackerel stock (see Sections 4.2 and 4.3). Table 4.3.1 shows the catches of this stock from 1982–1997. The total catch taken from this stock in 1997 was 19,500 t which is the same level as the previous two years. In previous years most of the catches from the North Sea stock were taken as a by-catch in the small mesh industrial fisheries in the fourth quarter carried out mainly in Divisions IVb and VIId. However, since 1995 at least 70% of the catch has been taken in a directed horse mackerel fishery for human consumption.

5.3 Fishery Independent Information, Egg Surveys

Horse mackerel egg surveys in the North Sea were carried out from 1988 to 1991 and the spawning stock biomass estimated were respectively 120, 217, 255 and 247 thousand tonnes (Eltink, 1992). The 1988 estimate was regarded as an underestimate. No egg surveys have been carried out since 1991.

5.4 Biological Data

5.4.1 Catch in numbers at age

Catch in numbers at age data were calculated according to Dutch data (Tables 5.4.1.1 and 5.4.1.2). In 1997 the Dutch catches comprised 57% of the total. For the earlier years age compositions were presented based on samples taken from smaller Dutch commercial catches and research vessel catches. These are available for the period 1987–1995. In the earlier years the Dutch samples covered only a small proportion of the total catch, but give a rough indication of the age composition of the stock (Figure 5.4.1.1).

The strength of the 1982 year class in the central and southern North Sea does not seem as strong as in the western area (Figures 5.4.1.1 and 6.4.1.1). The 1987 year class is relatively stronger in the western stock than in the North Sea. In the 1997 catches the 1994 year classes are relatively abundant both in the western catches and in the North Sea catches.

5.4.2 Mean length at age and mean weight at age

Mean length at age and mean weight at age in the catches based on the Dutch data are given in Tables 5.4.1.1 and 5.4.1.2.

5.4.3 Maturity at age

No data have been made available for this Working Group.

5.4.4 Natural mortality

There is no information available about natural mortality.

5.5 State of the stock

It was not possible to do an analytical assessment. Estimates of total age compositions are available only for the years 95, 96 and 97 based on mainly Dutch samples. Estimates of age compositions before 1995 are considered unreliable, that is, not representative for the entire fishery, and should not be used for analytical assessment.

The egg surveys carried out in 1989, 1990 and 1991 resulted in an average spawning stock biomass of 240,000 t over this period (Eltink, 1992). As the estimated stock biomass is large compared to the annual landings (4,000 t–33,000 t with an average of 18,000 t during the period 1982–1997), the stock may be lightly exploited.

If an assessment for this stock is required improved catch sampling and independent estimates of SSB are necessary.

5.6 Reference Points for Management Purpose

Reference points can not be defined for this stock, as estimates of recruitment and biomass are not available.

5.7 Harvest Control Rules

No harvest control rules were considered since no assessment was carried out.

5.8 Management Measures and Considerations

No forecast was made for 1999. The data were insufficient to define a management plan for this stock.

The Working Group recommends that if a TAC is set for this stock, it should apply to those areas where North Sea horse mackerel are fished, i.e. Divisions IVb,c, VIId, and eastern part of Division IIIa.

Table 5.4.1.1 Catch in numbers ('000), mean length (cm) and mean weight (g) at age of NORTH SEA HORSE MACKEREL by quarter and by Division(s) in 1997.

1997	IIIa	IVb,c	VIId	All areas
	1'st Q	1'st Q	1'st Q	1'st Q
Age	catch('000)	catch('000)	catch('000)	catch('000)
0	0	0	0	0
1	0	0	0	0
2	0	47	54	101
3	0	100	78	177
4	0	76	32	108
5	0	41	15	56
6	0	59	14	72
7	0	41	7	48
8	0	29	8	37
9	0	29	3	32
10	0	0	1	1
11	0	0	0	0
12	0	6	1	7
13	0	0	1	1
14	0	0	0	0
15+	0	0	0	0
Total	0	428	212	640
Tonnes	0	73	29	102

1997	IIIa	IVb,c	VIId	All areas
	1'st Q	1'st Q	1'st Q	1'st Q
Age	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0
2	0.0	22.5	22.0	22.2
3	0.0	23.4	23.4	23.4
4	0.0	24.5	24.7	24.6
5	0.0	25.5	25.6	25.5
6	0.0	26.7	26.5	26.7
7	0.0	27.2	27.1	27.2
8	0.0	28.5	28.2	28.4
9	0.0	28.9	29.1	28.9
10	0.0	0.0	28.5	28.5
11	0.0	0.0	0.0	0.0
12	0.0	31.5	32.0	31.6
13	0.0	0.0	30.5	30.5
14	0.0	0.0	0.0	0.0
15+	0.0	0.0	0.0	0.0
0-15+	0.0	25.4	24.1	24.9

1997	IIIa	IVb,c	VIId	All areas
	1'st Q	1'st Q	1'st Q	1'st Q
Age	weight(g)	weight(g)	weight(g)	weight(g)
0	0	0	0	0
1	0	0	0	0
2	0	119	108	113
3	0	128	126	127
4	0	148	145	147
5	0	166	162	165
6	0	180	176	179
7	0	186	186	186
8	0	230	211	226
9	0	230	218	229
10	0	0	204	204
11	0	0	0	0
12	0	305	291	303
13	0	0	240	240
14	0	0	0	0
15+	0	0	0	0
0-15+	0	163	138	155

	IIIa	IVb,c	VIId	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	catch('000)	catch('000)	catch('000)	catch('000)
0	0	0	0	0
1	0	0	0	0
2	0	6	22	28
3	0	8	32	40
4	0	3	13	17
5	0	2	6	8
6	0	1	6	7
7	0	1	3	3
8	0	1	3	4
9	0	0	1	2
10	0	0	0	0
11	0	0	0	0
12	0	0	1	1
13	0	0	0	0
14	0	0	0	0
15+	0	0	0	0
Total	0	22	88	110
Tonnes	0	3	12	15

	IIIa	IVb,c	VIId	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0
2	0.0	22.0	22.0	22.0
3	0.0	23.4	23.4	23.4
4	0.0	24.7	24.7	24.7
5	0.0	25.6	25.6	25.6
6	0.0	26.5	26.5	26.5
7	0.0	27.1	27.1	27.1
8	0.0	28.2	28.2	28.2
9	0.0	29.1	29.1	29.1
10	0.0	28.5	28.5	28.5
11	0.0	0.0	0.0	0.0
12	0.0	32.0	32.0	32.0
13	0.0	30.5	30.5	30.5
14	0.0	0.0	0.0	0.0
15+	0.0	0.0	0.0	0.0
0-15+	0.0	24.1	24.1	24.1

	IIIa	IVb,c	VIId	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	weight(g)	weight(g)	weight(g)	weight(g)
0	0	0	0	0
1	0	0	0	0
2	0	108	108	108
3	0	126	126	126
4	0	145	145	145
5	0	162	162	162
6	0	176	176	176
7	0	186	186	186
8	0	211	211	211
9	0	218	218	218
10	0	204	204	204
11	0	0	0	0
12	0	291	291	291
13	0	240	240	240
14	0	0	0	0
15+	0	0	0	0
0-15+	0	138	138	138

	IIIa	IVb,c	VIId	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	catch('000)	catch('000)	catch('000)	catch('000)
0	0	0	0	0
1	0	0	0	0
2	0	6,666	15	6,680
3	0	10,761	24	10,785
4	0	5,787	16	5,803
5	0	2,869	15	2,885
6	0	3,448	12	3,460
7	0	2,160	16	2,176
8	0	1,788	9	1,796
9	0	1,391	12	1,403
10	0	57	1	58
11	0	0	3	3
12	0	335	0	335
13	0	57	1	57
14	0	0	0	0
15+	0	443	4	446
Total	0	35,760	128	35,887
Tonnes	0	5,377	21	5,398

	IIIa	IVb,c	VIId	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	length (cm)	length (cm)	length (cm)	length(cm)
0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0
2	0.0	22.2	22.7	22.2
3	0.0	23.4	23.8	23.4
4	0.0	24.6	25.1	24.6
5	0.0	25.6	25.7	25.6
6	0.0	26.6	26.6	26.6
7	0.0	27.2	27.6	27.2
8	0.0	28.4	27.8	28.4
9	0.0	28.9	29.5	28.9
10	0.0	28.5	29.0	28.5
11	0.0	0.0	30.2	30.2
12	0.0	31.7	0.0	31.7
13	0.0	30.5	29.5	30.5
14	0.0	0.0	0.0	0.0
15+	0.0	31.0	33.7	31.0
0-15+	0.0	24.7	26.2	24.7

	IIIa	IVb,c	VIId	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	weight (g)	weight (g)	weight (g)	weight(g)
0	0	0	0	0
1	0	0	0	0
2	0	111	109	111
3	0	127	120	127
4	0	146	143	146
5	0	164	156	164
6	0	179	169	179
7	0	186	185	186
8	0	223	190	223
9	0	228	224	228
10	0	204	221	204
11	0	0	247	247
12	0	300	0	300
13	0	240	132	239
14	0	0	0	0
15+	0	282	354	283
0-15+	0	151	164	151

	IIIa	IVb,c	VIId	All areas
	4'th Q	4'th Q	4'th Q	4'th Q
Age	catch('000)	catch('000)	catch('000)	catch('000)
0	0	0	0	0
1	0	0	0	0
2	0	2,012	3,740	5,753
3	0	10,064	6,172	16,235
4	0	4,026	4,114	8,140
5	0	8,051	3,927	11,979
6	0	8,051	2,992	11,044
7	0	6,038	4,114	10,152
8	0	6,038	2,244	8,282
9	0	4,026	3,179	7,205
10	0	2,012	374	2,386
11	0	0	748	748
12	0	0	0	0
13	0	0	187	187
14	0	0	0	0
15+	0	0	935	935
Total	0	50,319	32,729	83,047
Tonnes	0	8,635	5,390	14,025

	IIIa	IVb,c	VIId	All areas
	4'th Q	4'th Q	4'th Q	4'th Q
Age	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0
2	0.0	23.5	22.7	23.0
3	0.0	24.1	23.8	24.0
4	0.0	25.5	25.1	25.3
5	0.0	25.5	25.7	25.6
6	0.0	26.5	26.6	26.5
7	0.0	27.2	27.6	27.4
8	0.0	27.8	27.8	27.8
9	0.0	29.5	29.5	29.5
10	0.0	31.5	29.0	31.1
11	0.0	0.0	30.2	30.2
12	0.0	0.0	0.0	0.0
13	0.0	0.0	29.5	29.5
14	0.0	0.0	0.0	0.0
15+	0.0	0.0	33.7	33.7
0-15+	0.0	26.3	26.2	26.3

	IIIa	IVb,c	VIId	All areas
	4'th Q	4'th Q	4'th Q	4'th Q
Age	weight(g)	weight(g)	weight(g)	weight(g)
0	0	0	0	0
1	0	0	0	0
2	0	129	109	116
3	0	138	120	131
4	0	162	143	152
5	0	153	156	154
6	0	169	169	169
7	0	187	185	186
8	0	194	190	193
9	0	238	224	232
10	0	245	221	241
11	0	0	247	247
12	0	0	0	0
13	0	0	132	132
14	0	0	0	0
15+	0	0	354	354
0-15+	0	172	164	169

Table 5.4.1.2 Catch in numbers, mean length and mean weight in catch for North Sea horse mackerel 1997

Age	Catch in numbers (millions)	Mean length (cm) in catch	Mean weight (kg) in catch
0	0.000		
1	0.000		
2	12.562	22.5	0.113
3	27.238	23.7	0.129
4	14.068	25.0	0.150
5	14.927	25.6	0.156
6	14.583	26.6	0.171
7	12.380	27.3	0.186
8	10.119	27.9	0.198
9	8.642	29.4	0.231
10	2.445	31.0	0.240
11	0.751	30.2	0.247
12	0.343	31.7	0.300
13	0.245	29.7	0.157
14	0.000		
15+	1.382	32.8	0.331

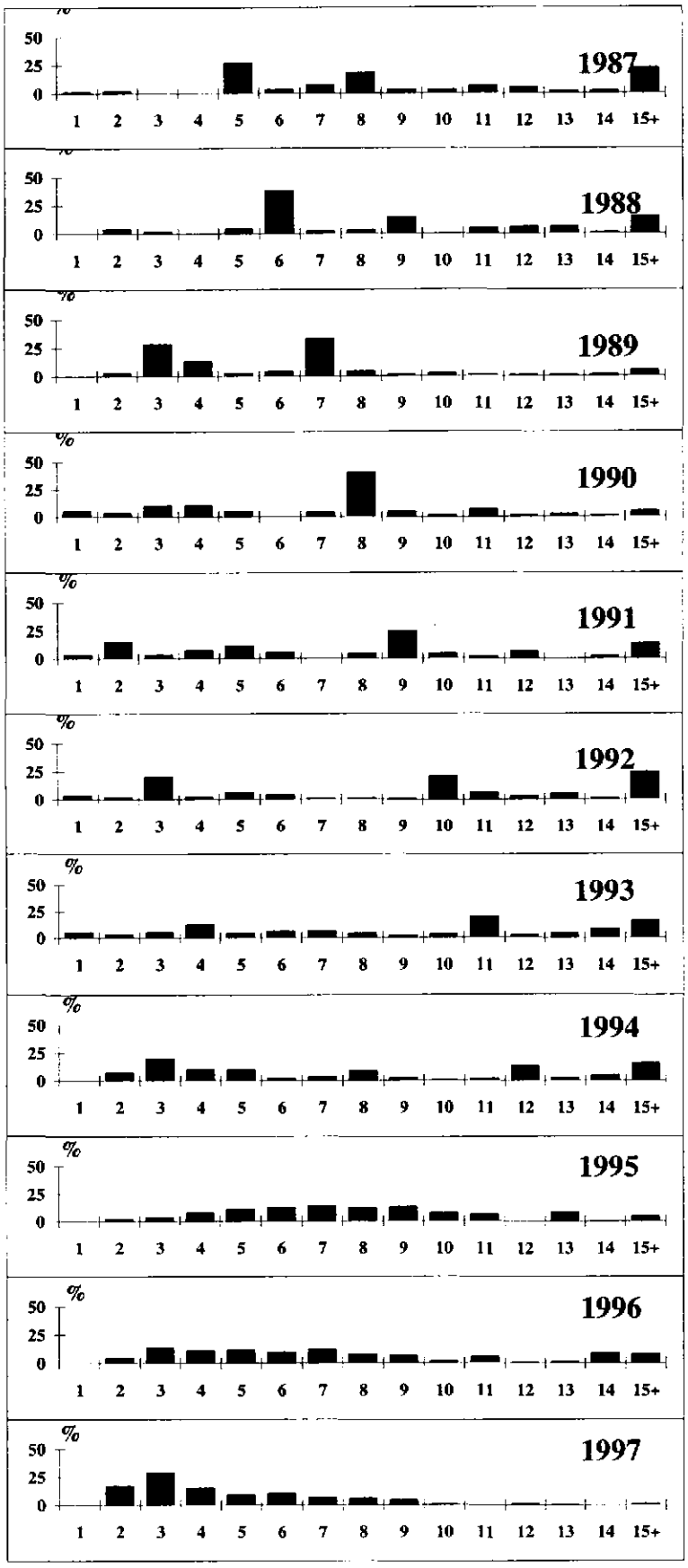

Figure 5.4.1.1 The age composition of the NORTH SEA HORSE MACKEREL based on commercial and research vessel samples from 1987-1997.

6 WESTERN HORSE MACKEREL (DIVISIONS IIa, IIIa (WESTERN PART), IVa, Vb, VIa, VIIa–c, VIIe–k, AND VIIIa,b,d,e

6.1 ACFM Advice Applicable to 1997 and 1998

Both for 1997 and 1998 ICES recommended a substantial reduction of fishing mortality, at least to 0.15 corresponding to a catch of 173,000 t, and 150,000 t in 1997 and 1998 respectively. This was aimed at maintaining the SSB above that which produced the 1982 year class. The TAC should apply to all areas where western horse mackerel are fished. The total landings of this stock in 1997 were 442,000 t which was 269,000 t more than recommended.

6.2 The Fishery in 1997

The fishery for the western horse mackerel is carried out in Divisions IIa, IIIa (western part) IVa, VIa, VIIa–c,e–k and VIIIa,b,d,e. The national catches taken by the countries fishing these areas are shown in Tables 6.2.1–6.2.5, while information on the development of the fisheries by quarter and division is shown in Table 4.1.2 and in Figures 4.1.1a–d.

Divisions IIa and Vb

The national catches in this area are shown in Table 6.2.1. The catches in this area have varied from year to year. The catches dropped from the record high catch of 14,000 t in 1995 to about 3,400 t in 1996 and 2,600 t in 1997.

Sub-area IV and Division IIIa (western part)

The total catches in this area have been above or close to 100,000 t during the period 1989 to 1995 (Table 6.2.2). In 1996 the catches dropped by about 75%, mainly because of considerable reduction in the Norwegian purse seine catches in Division IVa. Mainly due to increased Dutch and Norwegian catches in 1997 the total catch was 79,000 t.

Sub-area VI

The catches in this area have increased from 21,000 t in 1990 to a historical high level of 84,000 t in 1995 and 81,000 t in 1996 (Table 6.2.3). The catches in 1997 were reduced by 50% to 40,000 t. The main part of the catches is taken in a directed Irish trawl fishery for horse mackerel.

Sub-area VII

The catches from this area are mainly taken in directed Dutch and Irish trawl fisheries in Divisions VIIb,e,h,j (Table 6.2.4). The catches increased to a historical high level in 1995 of 330,000 t. After a reduction in the catches in 1996 of about 50,000 t the catches in 1997 were back at the high 1995 level.

Sub-area VIII

The catches from this area are mainly taken in Divisions VIIIa,b,d,e and given in Table 6.2.5. Historical high catches of more than 53,000 t were taken in 1992 and 1993. In 1995 the catches declined to 21,000 t and increased to 41,000 t in 1997.

6.3 Fishery Independent Information from Egg Surveys

The historic time series of stage 1 egg production and SSB estimates, for the western area from 1977 to 1985, was updated at the Working Group in 1997 (Table 2.2.1 in ICES 1998/Assess:6). No further changes have been made to that data set.

At the planning meeting in Lisbon for the 1998 mackerel and horse mackerel egg surveys of the western and southern areas, the Working Group agreed that preliminary results of the 1998 egg surveys would not be available in time for either the current Assessment Working Group or for the October meeting of ACFM. Although some egg survey results might be available by the end of September, work on the analysis of the samples for fecundity, atresia and maturity at age will not be completed until early in 1999. As a consequence only an incomplete set of egg survey results, are available from the 1998 egg survey (see Section 1.5.2) These data have not been subjected to a rigorous check and must therefore be regarded as only preliminary.

The following information, on egg distribution was available:

In the first sampling period in the western area, period 3, the major concentration of spawning was along the shelf edge from southern Biscay to the Great Sole Bank with some diffuse spawning to the north of that area over the Celtic Sea and to the west of Ireland. The boundaries of the distribution were fairly well defined in this period.

By the next sampling period spawning intensity had increased rapidly and was strongly associated with the shelf edge from southern Biscay to south-west of Ireland. The boundaries of the distribution were well defined except at the southern limit of the western area where concentrations of over 100 stage 1 eggs per m^2 were found.

Spawning had declined by the next period, period 5, with sporadic concentrations along the shelf edge from northern Biscay to west of Ireland with virtually no spawning north of 53°N. The results of sampling from central Biscay southwards were not available.

Spawning increased again in the final sampling period, period 6, to reach a seasonal peak, 50% above the production in period 4. Spawning was strongly concentrated in the area between 48°N and 54°N. and spread eastwards, from the shelf edge, into the Celtic Sea. The boundaries of this distribution were very well defined. A small, isolated, production of stage 1 eggs was also located in central Biscay but analysis of the samples in this area is not complete.

The preliminary estimate of stage 1 horse mackerel egg production, from the samples analysed to date, is approximately 20% lower than the production measured in 1995.

6.4 Biological data

6.4.1 Catch in numbers

As in previous years only two countries provided sample data with age readings, the Netherlands (Divisions VIa, Sub-areas IV, VII and VIII) and Norway (Division IIa, IVa). This means that about 43% of the catches were sampled for age determinations. Catches from other countries were converted to numbers at age using the Dutch and Norwegian data.

The catch in numbers at age by quarters and Divisions for western horse mackerel is shown in Table 6.4.1.1. The total annual catch in numbers for 1997 is shown in Table 6.4.1.2. The sampling intensity is discussed in Section 1.3. The 1982 year class has until last year (Figure 6.4.1.1) been the most numerous in the catches from the western stock. This age group is now part of the plus group which is 8% of the total catch in numbers.

6.4.2 Mean length at age and mean weight at age

Mean length at age and mean length at age in the catches

Mean weights and mean lengths at age in the catches by quarters in 1997 were as usually provided only by Netherlands and Norway. These data were applied to the catches from other countries. The mean weight and mean length at age in the catches are shown in Tables 6.4.1.2, 6.4.2.1, and 6.4.2.2.

Mean weight at age in the stock

As for previous years the mean weight at age for the two years old was given a constant weight while the weight for the older ages is based on all mature fish sampled from Dutch freezer trawlers the first and second quarter in Divisions VIIj,k (Table 6.4.1.2).

Projected weights at age in catches and in the stock 1998–2007

Projected weights at age in the catches and weights at age in the stock are needed for the forecasts. The mean weights at age in the catch and in the stock for the period 1997–2007 were, except for the 1982 and the 1987, set as the mean weights from 1995, 1996 and 1997. The weight at age in catch and in the stock of the 1982 and the 1987 year classes were obtained from extrapolated growth curves over the period 1998–2007. The mean weights at age in the catch and in the stock of the 1982 year class have been used for the 15+ group since the majority of this group consists of the 1982 year class. The projected weights at age in catches and in the stock for 1998–2007 are given in Table 6.8.1.1.

6.4.3 Maturity at age

Annual changes in the mean weights at age are expected to be related to annual changes in the maturity ogive. Therefore, the maturity ogive should be estimated for each year to take into account possible differences in growth rates. This was discussed in ICES (1998/Assess:6).

During the mackerel/horse mackerel egg surveys in 1998 horse mackerel were collected to estimate the proportion mature by histological analysis to improve the maturity ogive. However, these data are not analysed yet.

6.4.4 Natural mortality

The natural mortalities applied in the assessments of western horse mackerel are summarised and discussed in ICES (1998/Assess:6) and the Working Group admitted uncertainties in M in the range of 0.05 to 0.15.

6.5 State of the Stock

A Bayesian approach has been used to calculate the Western horse mackerel stock assessment. This has been chosen as being an appropriate method of admitting perceived uncertainties in assumptions in the assessment, and of estimating uncertainties in the perceptions of stock size and subsequent short- and medium-term forecasts. An accessible introduction to Bayesian methodology in a fisheries context is given by Hilborn and Walters (1992). Estimates calculated by this approach can reflect uncertainty in assumptions as well as noise in the data around a given structural model. One difference between the Bayesian and conventional approach is that no attempt is made to find a 'best' set of parameter estimates or 'best' VPA. Instead, over a wide range of plausible prior assumptions, the data are compared with the assessment model using a likelihood function. For any particular parameter such as spawning stock size or a future catch under a particular catch option, the perceived ('posterior') probability of each stock size or catch option can be calculated. It is not necessarily the case that the likeliest estimates of all the parameters, or even their expected values, should be consistent through a single calculation of the assessment model. This can happen because of nonlinearities and parameter correlations in the assessment model. The Working Group does not therefore provide a single 'final' VPA, but instead provides expected values and distribution percentiles for quantities judged to be of management interest. The calculating mechanism is described briefly in Appendix 1 of ICES (1998/Assess:6), which is a summary of a description given in Patterson (1997).

As has been noted in two previous Assessment Working Group reports (ICES 1996/H:2, ICES 1997/Assess:3) the assessment of Western horse mackerel presents peculiar and special difficulties. The stock is dominated by two cohorts, the extremely strong 1982 and the much less abundant 1987 year classes comprising the bulk of the catches in recent years. Although there exist plausible catch-at-age data for the period 1982 to 1996 and there also exists a time-series of egg survey estimates of spawning biomass (ICES 1996/H:2) it is not a straightforward task to use the egg survey estimates to 'tune' a population model to the egg survey estimates. This is because maturation of horse mackerel appears to be density-dependent, and also because sampling for maturation is subject to unknown bias due to migration effects. Lastly, the assumption of natural mortality, M = 0.15 was made arbitrarily. Alternative choices of M were explored briefly by ICES (1997/Assess:3) which suggested that lower rather than higher values of M may provide better fits of VPA-derived population models to egg survey biomass estimates.

The problematic nature of the assessment has led to rather poor consistency in advice. Estimates of the abundance of the 1982 year class have been revised upwards successively by successive working groups, and as new egg survey estimates were added to the time-series, the perception of the precision of the earlier surveys was diminished.

Here an attempt is made to make a more comprehensive assessment of uncertainty in some quantities used for management purposes (spawning stock size, fishing mortality, $F_{status\ quo}$ catch) that includes uncertainty in some critical quantities (maturity ogive, natural mortality). A Bayesian VPA-based method based on a Markov Chain Monte Carlo method similar to that used for Norwegian Spring-Spawning Herring (Patterson and Eltink, WD 1997) is used. In addition to the age-structured observation data set, this requires the specification of prior distributions for quantities about which limited or subjective knowledge is available.

6.5.1 Model

6.5.1.1 Structural model for assessment

As last year, the underlying structural population model is of the 'ADAPT' type, structured so as to make all historic and recent population abundances and mortalities dependent on two parameters, being the abundance of fish aged 14 on 1 January 1998 and the natural mortality. The model is similar to that described by ICES (1997/Assess:3), albeit with slightly different exploitation pattern assumptions. The following constraints were imposed:

- Selection (relative fishing mortality) in 1997 and later years is constrained = 1 on ages 4 and older.
- Selection on ages 0 to 3 in 1997 is calculated by linear interpolation between 1 at age 4 and 0 at age 0;
- Fishing mortality on the oldest age is taken as the arithmetic mean from age 6 to the penultimate true age in the catch at age matrix.

- Recruitments from 1994 to 1997 were modelled as a geometric mean of recruitments in the years 1981, 1983–1986 and 1988–1992 (see Section 6.8) in order to avoid inferring recent recruitments from a selection pattern assumption.

6.5.1.2 Probability model

The likelihood function is defined analogously to that for the conventional assessment, based on the lognormal distribution. With usual notation indexed by year y and age a, (Egg surveys U_y, Population abundance $N_{a,y}$, Maturity ogive O, fishing mortality F, natural mortality M, survey variance sigma and the proportions of fishing and natural mortality experienced before the time of the survey PF and PM):

$$P(\text{Data} \setminus \text{Model}) = \Pi_y \left(\frac{1}{U_y \sigma (2\pi)^{1/2}} \exp\left(- \frac{[\log(U_y / \Sigma_a N_{a,y} O_{a,y} W_{a,y} \exp(-PF.F_{a,y} - PM.M_{a,y}))]^2}{2\sigma^2} \right) \right)$$

6.5.2 Data and priors

6.5.2.1 Data assumed known precisely

Estimates of landings and estimates of catches at age in numbers, weights at age in the catches and weights at age in the stock were as described in Sections 6.4.1 and 6.4.2 and given in Tables 6.5.2.1 to 6.5.2.3.

6.5.2.2 Uncertainty in maturity

The assumptions concerning the uncertainty in maturity were comprehensively discussed in last year's report (ICES 1998/Assess:6). The following assumptions for the prior distributions for maturity have been made, based on hypotheses about plausible maturities that are described in Section 6.5:

1. The strongest year class before the 1982 year class was the 1979 year class, which did not show a retarded growth until 1983. The percentage mature is assumed to be in the range of 75% to 100% with equal probability for all values.

2. Fish of the 1982 year class in 1983 at age 1 are assumed to be all immature, no uncertainty admitted.

3. Because of the retarded growth, the fish of the 1982 year class in 1986 and 1989 at respectively ages 4 and 7 are assumed to have a completely unknown maturity in the range of 0 to 100% with equal probability. It is assumed that the maturity in 1989 must be greater than in 1986.

4. Fish of the 1982 year class in 1992 at age 10 are assumed in the range of 80 to 100% mature with equal probability.

5. Fish of the year class 1992 in 1995 at age 3 are assumed to have a maturity in the range of 0 to 100%, but less mature than the 1979 year class in 1983.

6. Fish of the 1982 year class in 1995 at age 13 are assumed to be all mature with no uncertainty admitted.

These maturity assumptions described above were parameterised as follows, and depending on five parameters $X_{1\text{-}5}$:

$$MO(1983,4)=X_1$$
$$MO(1986,4)=X_2$$
$$MO(1989,7)=X_3(1-X_2)+X_2$$
$$MO(1992,10)=X_4$$
$$MO(1995,3)=X_5.X_1$$

The maturity at age for the remaining years and ages are given in Table 6.5.2.4.

6.5.2.3 Uncertainty in natural mortality

In the 1996 assessment of this stock trials with M in the region +/- 50% around M=0.15 were made. Here we consider admissible hypotheses for M in the range 0.05 to 0.15, for reasons referred to in Section 6.4. No attempt was made to explore uncertainty about possible differences in natural mortality at age.

6.5.2.4 Egg survey data

The coefficient of variation of the 1992 western horse mackerel egg survey estimates was estimated at between 18 and 22% depending on the analytic method used (ICES 1994/H:4). For present purposes the egg survey abundances estimates were assumed to be estimated with a CV of 25% on a lognormal distribution. No uncertainty was admitted in this variance estimate.

This year a preliminary estimate of the spawning stock biomass was available from the 1998 surveys (Section 6.3). Due to the recent downwards trend in the ADAPT estimates of SSB, which have been projected to go below the MBAL of 500kt in the short term, the Working Group considered that the preliminary estimate should be included within the assessment. Although it is considered that when the final egg survey estimate is available next year the value will be revised, it was treated as having the same CV as the previous surveys.

6.5.2.5 Summary of prior assumptions

The prior distributions are summarised in the text table below. All prior distributions are uniform.

Parameter		Lower Bound	Upper Bound	Comment
$N_{1998,14}$	Population Abundance (thousands)	1000	$8 . 10^9$	Unrestrictive, reference parameter for VPA
M	Natural Mortality	0.05	0.15	Section 6.4
X_1	Maturity 1983 age 4	0.75	1.0	Section 6.5.2.2
X_2	Maturity 1986 age 4	0	1.0	
X_3	Maturity 1989 age 7, additional to maturity 1986 age 4	0	1.0	
X_4	Maturity 1992 age 10	0.8	1.0	
X_5	Relative Maturity 1995 age 3	0	1.0	

6.5.3 Stock assessment

Estimates of the historic development of the stock parameters are plotted in Figure 6.5.3.1, and the expectations and 5th, 25th, 50th, 75th and 95th percentiles of these distributions are given in Table 6.5.3.1. From Figure 6.5.3.1. it can be seen that the 1983 and 1986 egg survey observations lie outside the 95th percentile of the SSB distribution, indicating that even with the relaxation of assumptions allowed in this assessment compared with the conventional assessment procedure, the early egg surveys in the time series, the reported catches, the VPA assumptions and the assumption of a 25% CV in egg survey estimates are mutually incompatible. The preliminary estimate for the 1998 survey biomass lies within the 95 percentile of the stock trajectory.

It should be noted from Figure 6.5.3.1 that the SSB estimates in the majority of years in which the Bayesian priors have been applied to maturity at age (1986, 1989, 1992, 1995), appear to be biased towards the egg survey values. This may result from lower expected values for maturity at age in the survey years when compared to the deterministic values of adjacent years. A future development of the model, which should be considered is the use of a density dependent model for maturity.

6.5.4 Reliability of the assessment and uncertainty estimation

Posterior distributions for population abundance, natural mortality and spawning biomass in 1997 and 1998 (the latter predicated on an assumption of a catch of 400,000 t in 1998) are shown in Figure 6.5.4.1. The distribution of the ratio F/M is plotted because as both F and M are uncertain parameters, the distribution of F alone has an uncertain meaning. This shows that:

1. The data and model indicate values of natural mortality higher than 0.12 are improbable.
2. The lower limit of natural mortality is constrained by the prior assumptions, and the data and model do not give information about this lower limit.
3. Spawning stock size estimates of 945,000 t to 1,420,000 t (25th and 75th percentiles) in 1997 are calculated.
4. Estimates of the ratio of fishing mortality to natural mortality in 1997 2.86 to 4.66 (25th and 75th percentiles) are calculated.

5. The distribution of the estimate of spawning stock biomass in 1983, which has been used for reference purposes, is 838,000 t to 1,030,000 t (25th and 75th percentiles).

Perceptions of maturity parameter estimates (X_1 to X_5) are given in Figure 6.5.4.2. This shows that there is little information in the model and data about these parameters, with the exception that lower values of maturity of the age 4 fish in 1986 appear more likely.

Comparisons between the SSB trajectories from this year's assessment (Figure 6.5.4.3a) with last year's, (Figure 6.5.4.3b) reveal that whereas the 1989, 1992 and 1995 surveys were close to the median line last year, the new assessment estimates that they lie between the 75th and 95th percentiles. This shows that the assessment results are very sensitive to the egg survey estimate for 1998 and revisions to this when the data are finalised could have a significant effect on the estimated trends in stock size and mortality.

6.6 Catch Prediction

A calculation of the consequences of different short-term catch options can be made from the Bayesian assessment, but a different presentation is necessary to take account of the fact that most of the important variables (stock size, natural mortality, fishing mortality etc.) are treated as stochastic. No attempt is made to find a joint maximum-likelihood solution. A stochastic version of the conventional catch option table is presented in Table 6.6.1.

The following assumptions were made in the calculations:

1. Recruitments in 1994 and later were treated as lognormal variates with mean and variance estimated from the mean and variance of the recruitments in 1981, 1983–1986 and 1988–1993. This treatment is as used by ICES (1997/Assess:3) and represents a cautious approach to modelling recruitment as the mean and variance of the weak year classes, ignoring the few stronger year classes.

2. Exploitation in 1998 and later was assumed to follow the selection pattern assumed for 1997.

3. Catches in 1998 were assumed to be 400,000 t (Section 6.8.3). The assumption of 400,000 t in 1998 was thought preferable to an assumption of *status quo* fishing mortality, because such a mortality would imply much lower catches than those which are expected from this stock.

4. Weights at age in the stock and in the catch, and maturity in years 1998 and later, were taken as the average of the years 1995 to 1997.

5. Options of F=M, and of Catch (1999) = Catch (2000) = 50, 100, 200, 300 and 400 thousand tonnes were simulated.

6. In the simulations, an upper bound restriction was placed on fishing mortality = 1.5, in order to avoid simulations of extreme fishing mortalities when a catch constraint is imposed on a stock size which has a stochastic distribution which may extend to low values (possibly lower than the putative catch constraint).

For each option, the expectation of spawning stock size in 1999 and 2000, and the 25th, 50th and 75th percentiles of the SSB distribution are tabulated. The risk that the stock size may fall under each of two reference levels. These reference levels are the model estimate of SSB in 1983 and a value of 500,000 t.

Presentation of the F=M-based option is somewhat complex, as both M and the F=M catch are here considered as uncertain. Here, for the F=M option, the distribution of corresponding SSB has been tabulated, and also the distribution of the corresponding catch. However, it would be incorrect to interpret the former as being conditional on the expectation of the latter.

6.7 Short-Term Risk Analysis and Medium-Term Projections

A calculation of risk was made for some levels of fishing mortality between 0.1M and 3M, expressed as the probability of the stock being under 500,000 t at spawning time in 2000 and 2007. This calculation was made from estimates of the probability distribution of spawning stock size using the assumptions given above, but assuming exploitation between 1998 and 2007 = 0.1M, 0.25M, ... 3M. Risk so calculated is given in Figure 6.7.1.

The outcome of some simple harvest strategies in the medium term was evaluated by taking samples from the multivariate posterior distribution of parameters for the stock assessment, and projecting from each drawn parameter sample under the harvest control from 1999 until 2007.

The assumptions described in Section 6.5.2 were retained for all cases. The following scenarios were modelled, applying from 1999 onwards:

(1) Constant catch = 50, 100, 200, 300 or 400 thousand tonnes by year.
(2) Constant fishing mortality = natural mortality.

Some percentiles of the distribution of fishing mortality, recruitment, spawning stock size and landings, calculated under these assumptions, are given in Figures 6.7.2 to 6.7.7.

6.8 Comparative Assessment

6.8.1 ADAPT maximum-likelihood assessment

An alternative method is the 'ADAPT'-type method (Gavaris, 1988) in which an arbitrary choice of selection pattern is made. This method has been used at earlier Working Group meetings in 1994–1997 to estimate the size of this stock and associated mortality rates. This method is again used at this year's Working Group meeting for comparability with last year's ADAPT assessment and with the Bayesian assessment. The use of the ADAPT method also allows estimation of some of the uncertainty in the assessment, and of the sensitivity of the assessment to the assumed selection pattern. As fishing mortality has historically been rather low in this stock, VPA 'convergence' does not help stabilise the analysis rapidly and hence the population model is likely to be strongly dependent on starting assumptions.

The model is a conventional VPA, which is fitted by a non-linear minimisation of the sum of squares with respect to population abundance at age 14 in 1998 subject to the constraints detailed below. Given population abundance N, fishing mortality F, natural mortality M, weights at age W, and maturity at age O, egg survey estimates of SSB U, and the proportion of fishing and natural mortality exerted before spawning PF and PM respectively, the VPA is fitted by minimising:

$$\sum_y \left(\ln(U_y) - \ln\left(\sum_{a,y} N_{a,y}.O_{a,y}.W_{a,y}.\exp(-PF.F_{a,y} - PM.M_{a,y})\right)\right)^2$$

where subscripts a and y denote age and year respectively.

Given the lack of age-structured surveys it is necessary to impose some constraints about the exploitation pattern on the model. Although some of these constraints are not very realistic there are insufficient observations available to make objective parameter estimations. These constraints are somewhat arbitrary:

a) Selection pattern in 1997 and later years is equal to 1 on ages 4 and older (based on exploratory runs);
b) Selection on ages 0 to 4 in 1995 and later years set to mean from previous 3 years 1994 to 1996 (in last year's assessment a mean over 5 years was used); this change was made to avoid an unreasonably low stock number estimation for the 1996 year class;
c) Natural mortality, weights at age in the stock and in the catch are assumed to be known precisely;
d) Maturity ogive is assumed to be known precisely.
e) Fishing mortality on the oldest age taken as an arithmetic mean from age 6 to the penultimate true age in the catch at age matrix.

The choices made about constraints listed above were made after a number of exploratory model fits, which are documented in ICES (1996/Assess:7). As before, egg survey information prior to 1992 was excluded on account of uncertainty introduced by the unknown maturity of the 1982 cohort.

The model is fitted to the traditional egg production estimates of biomass (Table 6.8.1.2d) only for the 1992, 1995 and the preliminary 1998 estimates (which are expected to be approximately 80% of the 1995 value). Preliminary runs with the ADAPT were made without including an SSB estimate from the 1998 egg survey. These runs resulted in an increase of F to more than 0.5 and a corresponding reduction of the stock size estimation. As this drastic change in stock parameters could not be justified by other information, it was decided to use the preliminary results of the 1998 egg survey for tuning. In general, the output from the ADAPT assessment has shown to be very sensitive on the constraints listed above and the inclusion or exclusion of the 1998 egg survey biomass estimate.

Input data for the assessment and projections are given in Table 6.8.1.1, fishing mortality, fitted populations, stock sizes and other parameters calculated by the ADAPT procedure are presented in Table 6.8.1.2. In Figure 6.8.1.1 some of these parameters are compared graphically. From Figure 6.8.1.1b it is striking that the VPA fit of SSB (expected) to the SSB estimates from egg surveys (observed) shows a striking discrepancy. This may be caused by invalid assumptions made on the following parameters:

- natural mortality (however, an exploratory run with M reduced to M=0.05 improved the fit considerably and brought it very close to the results of the Bayesian analysis, as shown in Figure 6.8.1.3),
- selection pattern, which was presumed to be constant, but might have changed over the last years (and there are indications for this, see Figure 6.4.1.1),
- maturity ogive,
- treatment of the SSB estimates as absolute measures of stock abundance,
- age composition estimates could be biased due to poor sampling coverage,
- the model structure might have been inappropriate.

6.8.2 Comparison with GAM egg production estimate

Population parameter estimates obtained using GAM estimates of egg production were presented in the 1996 Working Group report (ICES 1997/Assess:3, Figure 6.2). and the comparison with the traditional estimates was not updated.

6.9 Long-Term Yield

Given the uncertainty, both to the mortalities and to the future recruitment, long-term yield has not been computed.

6.10 Uncertainty in Assessment

The assessment calculation expressed in Section 6.5 and concomitant forecasts in Sections 6.6 and 6.7 are made with an explicit consideration of perceived uncertainty in natural mortality, egg survey biomass estimates and in maturity parameters for specific ages in the early years of the egg survey. Distribution percentiles for various quantities from the assessment and short-term projection are given in Tables 6.5.3.1 and 6.6.1, which represents the best available estimates of quantified uncertainty.

Additional, unquantified uncertainty exists. The following sources of uncertainty have not been taken into account in the assessment:

- Uncertainty about reported catches;

- Uncertainty about selection pattern assumptions, which have a strong effect on the estimation of recent recruitments;

- Uncertainty in maturity, except for the years and ages mentioned in Section 6.5.2.2. In particular it should be noted from Figure 6.5.3.1 that the SSB estimates in the majority of years in which the Bayesian priors have been applied to maturity at age (1986, 1989, 1992, 1995), appear to be biased towards the egg survey values. This may result from lower expected values for maturity at age in the survey years when compared to the deterministic values of adjacent years. A future development of the model, which should be considered is the use of a density dependent model for maturity, the parameters for which are estimated within the objective function;

- Uncertainty in stock weights and catch weights at age, either for the historic, measured values of for future, projected values;

- Uncertainty in sampling and ageing commercial catches;

- Treatment of the egg survey estimates as absolute measures of stock abundance.

Uncertainty in natural mortality has been incorporated into the model by the use of the Bayesian prior. The posterior distribution has established that within the structure of the model used for the assessment the highest probability of agreement between the estimated SSB and the egg surveys is achieved at the lowest bound of the natural mortality distribution. Although this could be taken as an inference for too high a value of natural mortality, the final natural mortality distribution could be artificially induced by mis-specification of the model structure, specifically - selection at age, maturity at age and/or the use of an absolute scaling for the egg survey estimates.

6.11 Reference Points for Management Purposes

6.11.1 MBAL

This stock is characterised by infrequent, extremely large recruitments. As only a short time series of data is available, it is not possible to quantify stock-recruit relationships, but one may make the precautionary assumption that the likelihood of a strong year class appearing would decline if stock size were to fall lower than the stock size at which the only such event has been observed. The basis for the level of MBAL is the stock size in 1983 (as estimated by an egg survey and the assessment), which is used as a proxy for the stock size present in 1982; that which produced the strong 1982 year class.

As noted above, population model estimates of the SSB in 1983 differ from the egg survey biomass estimate. The model estimates are in the range 756 to 1281 thousand tonnes with 90% confidence, yet the egg survey biomass estimate was 530,000 t. This year's assessment has not altered the estimate or the confidence limits. However, in Section 6.10 it is noted that the assessment of uncertainty in the population model estimates is incomplete, and therefore it is proposed to retain the use of the egg survey biomass estimate as the reference value for MBAL. Conventionally this has been rounded to 500,000 t. The Study Group on the Precautionary Approach to Fisheries Management has accepted this Working Group's recommendation that these values should be used as the SSB reference point B_{pa}.

6.11.2 Fishing mortality reference points

Given the extreme dynamics of the stock it is inappropriate to attempt to calculate F_{msy}, F_{med} or F_{low} reference points over the time series available. Possibly useful reference points for management purposes might be F=M, F=2/3M or $F_{0.1}$. A probability distribution for estimates of $F_{0.1}$ and $F_{0.1}$ relative to M from the stock assessment is shown in Figure 6.11.2.1. The percentiles of the distribution $F_{0.1}$ relative to M are given in the text table below:

Expected	5%	25%	50%	75%	95%
1.25	1.02	1.13	1.26	1.36	1.45

This illustrates that even these measures may be problematic as management tools, due to the uncertainty of their estimates in this assessment.

6.12 Harvest Control Rules

No harvest control rules were proposed by the Study Group on the Precautionary Approach to Fisheries Management and none are proposed here. However, the stock is at present in a transition from harvesting the large 1982 year class to the fishing of younger ages. Given the structural uncertainties within the model it was considered that the definition of harvest control rules would be inappropriate. At a later stage, a harvesting strategy will need to be provided, which can be applied when a large year class dominates the stock structure.

6.13 Environmental Effects

The Norwegian fishery for horse mackerel is unregulated and is carried out by purse seiners mainly in the Norwegian economical zone in the North Sea in October. This fishery is therefore reflecting the availability of horse mackerel in these areas. There is good correlation between modelled inflow of Atlantic water the first quarter of a year and the Norwegian horse mackerel catches later that year (Iversen *et al.* 1998). This relation may be used for predictive purposes. Based on the modelled inflow in the winter 1997 a Norwegian catch of 70,000 t was predicted that year. Norway took 46,000 t in 1997, and that was an increase of about 30,000 t since 1996. The development of the Norwegian fishery for horse mackerel indicates that the stock size has to be above a certain level before it undertakes the migration northwards to the feeding areas and thereby becomes available for the Norwegian purse seiners. Given that the western horse mackerel stock is still above this level, the modelled influx the first quarter of 1998 predicts a Norwegian catch of about 30,000 t this year.

6.14 Management Considerations

Given the poor state of knowledge about the long-term dynamics of this stock, the Working Group suggests that management may wish to consider constant fishing mortality options in the range below natural mortality. According to the medium-term predictions (Figures 6.7.1–6.7.7), this will imply a gradual decrease in the risk for the stock of falling below MBAL of 500,000 t in the years immediately after 1998. Both the medium-term projections and comparisons with other stocks suggest that fishing with F/M=1 would lead to precautionary management. Even in this range, however, it is estimated (based on the assumption of continued low recruitment) that the spawning stock size has a probability around 10% of falling under MBAL by 2002.

TAC has been overshot considerably since 1988 (ICES 1997/Assess:3). The Working Group advises that if a TAC is set for this stock, it should apply to all areas where western horse mackerel are caught, i.e. Divisions IIa, IIIa (western part), IVa, Vb, VIa, VIIa–c, VIIe–k and VIIIa,b,d,e.

Table 6.2.1 Landings (t) of HORSE MACKEREL in Sub-area II. (Data as submitted by Working Group members.)

Country	1980	1981	1982	1983	1984
Denmark	-	-	-	-	-
France	-	-	-	-	1
Germany, Fed.Rep.	-	+	-	-	-
Norway	-	-	-	412	22
USSR	-	-	-	-	-
Total	-	+	-	412	23

Country	1985	1986	1987	1988	1989	1990	1991
Faroe Islands	-	-	-	-	-	964[3]	1,115
Denmark	-	-	39	-	-	-	-
France	1	-[2]	-[2]	-[2]	-	-	-
Germany, Fed.Rep.	-	-	-	64	12	+	-
Norway	78	214	3,272	6,285	4,770	9,135	3,200
USSR	-	-	-	469	27	1,298	172
UK (England + Wales)	-	-	-	-	-	17	-
Total	79	214	3,311	6,818	4,809	11,414	4,487

	1992	1993	1994	1995	1996	1997[1]
Faroe Islands	9,157[3]	1,068	-	950	1,598	799[3]
Denmark	-	-	-	200	-	-
France	-	-	55	-	-	-
Germany	-	-	-	-	-	-
Norway	4,300	2,100	4	11,300	887	1,170
Russia	-	-	700	1,633	881	648
UK (England + Wales)	-	-	-	-	-	-
Total	13,457	3,168	759	14,083	3,366	2,617

[1]Preliminary.
[2]Included in Sub-area IV.
[3]Includes catches in Division Vb.

Table 6.2.2 Landings (t) of HORSE MACKEREL in Sub-area IV by country. (Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984
Belgium	8	34	7	55	20
Denmark	199	3,576	1,612	1,590	23,730
Faroe Islands	260	-	-	-	-
France	292	421	567	366	827
Germany, Fed.Rep.	+	139	30	52	+
Ireland	1,161	412	-	-	-
Netherlands	101	355	559	2,029[4]	824
Norway	119	2,292	7	322	[4]
Poland	-	-	-	2	94
Sweden	-	-	-	-	-
UK (Engl. + Wales)	11	15	6	4	-
UK (Scotland)	-	-	-	-	3
USSR	-	-	-	-	489
Total	2,151	7,245	2,788	4,420	25,987

Country	1985	1986	1987	1988	1989	1990
Belgium	13	13	9	10	10	13
Denmark	22,495	18,652[2]	7,290[2]	20,323[2]	23,329[2]	20,605[2]
Estonia	-	-	-	-	-	-
Faroe Islands	-	-	-	-	-	942
France	298	231[3]	189[3]	784[3]	248	220
Germany, Fed.Rep.	+	-	3	153	506	2,469[6]
Ireland	-	-	-	-	-	687
Netherlands	160[4]	600[4]	850[4]	1,060[4]	14,172	1,970
Norway[2]	203	776	11,728[5]	34,425[5]	84,161	117,903
Poland	-	-	-	-	-	[2]
Sweden	-	2[2]	-	-	-	-
UK (Engl. + Wales)	71	3	339	373	10	102
UK (N. Ireland)	-	-	-	-	-	10
UK (Scotland)	998	531	487	5,749	2,093	-
USSR	-	-	-	-	-	458
Unallocated + discards	-	-	-	-	-12,482[5]	-
						-317[5]
Total	24,238	20,808	20,895	62,877	112,047	145,062

Country	1991	1992[7]	1993	1994	1995	1996	1997[1]
Belgium	-	+	74	57	51	28	-
Denmark	6,982[2]	7,755	6,120	3,921	2,432	1,433	648
Estonia	-	293	-		17	-	-
Faroe Islands	340	-	360	275	-	-	296
France	174	162	302		-	-	-
Germany, Fed.Rep.	5,995	2,801	1,570	1,014	1,600	7	7,603
Ireland	2,657	2,600	4,086	415	220	1,100	8,152
Netherlands	3,852	3,000	2,470	1,329	5,285	6,205	37,778
Norway[2]	50,000[2]	96,000	126,800	94,000	84,747	14,639	45,314
Poland	-	-	-		-	-	-
Sweden	953[2]	800	697	2,087	-	95	232
UK (Engl. + Wales)	132	4	115	389	478	40	242
UK (N. Ireland)	350	-	-		-	-	-
UK (Scotland)	7,309	996	1,059	7,582	3,650	2,442	10,511
USSR	-	-	-		-	-	-
Unallocated + discards	-750[5]	-278	-3,270	1,511	-28	136	-31,615
Total	77,994	114,133	140,383	112,580	98,452	26,125	79,161

[1]Preliminary. [2] Includes Division IIIa. [3] Includes Division IIa. [4] Estimated from biological sampling. [5] Assumed to be misreported. [6] Includes 13 t from the German Democratic Republic. [7] Includes a negative unallocated catch of -4,000 t.

Table 6.2.3 Landings (t) of HORSE MACKEREL in Sub-area VI by country. (Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988
Denmark	734	341	2,785	7	-	-	-	769	1,655
Faroe Islands	-	-	1,248	-	-	4,014	1,992	4,450[3]	4,000[3]
France	45	454	4	10	14	13	12	20	10
Germany, Fed. Rep.	5,550	10,212	2,113	4,146	130	191	354	174	615
Ireland	-	-	-	15,086	13,858	27,102	28,125	29,743	27,872
Netherlands	2,385	100	50	94	17,500	18,450	3,450	5,750	3,340
Norway	-	5	-	-	-		83	75	41
Spain	-	-	-	-	-		-[2]	-[2]	-[2]
UK (Engl. + Wales)	9	5	+	38	+	996	198	404	475
UK (N. Ireland)						-	-	-	-
UK (Scotland)	1	17	83	-	214	1,427	138	1,027	7,834
USSR	-	-	-		-	-	-	-	-
Unallocated + discards						-19,168	-13,897	-7,255	-
Total	8,724	11,134	6,283	24,881	31,716	33,025	20,455	35,157	45,842

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997[1]
Denmark	973	615	-	42	-	294	106	114	780
Faroe Islands	3,059	628	255	-	820	80	-	-	-
France	2	17	4	3	+	-	-	-	52
Germany, Fed. Rep.	1,162	2,474	2,500	6,281	10,023	1,430	1,368	943	229
Ireland	19,493	15,911	24,766	32,994	44,802	65,564	120,124	87,872	22,474
Netherlands	1,907	660	3,369	2,150	590	341	2,326	572	498
Norway	-	-	-	-	-	-	-	-	-
Spain	-[2]	-[2]	1	3	-	-	-	-	-
UK (Engl. + Wales)	44	145	1,229	577	144	109	208	612	56
UK (N.Ireland)	-	-	1,970	273	-	-	-	-	767
UK (Scotland)	1,737	267	1,640	86	4,523	1,760	789	2,669	14,452
USSR	-	44	-	-	-	-	-	-	-
Unallocated + discards	6,493	143	-1,278	-1,940	-6,960[4]	-51	-41,326	-11,523	837
Total	34,870	20,904	34,456	40,469	53,942	69,527	83,595	81,259	40,145

[1]Preliminary.
[2]Included in Sub-area VII.
[3]Includes Divisions IIIa, IVa,b and VIb.
[4]Includes a negative unallocated catch of -7,000 t.

Table 6.2.4 Landings (t) of HORSE MACKEREL in Sub-area VII by country. Data submitted by the Working Group members).

Country	1980	1981	1982	1983	1984
Belgium	-	1	1	-	-
Denmark	5,045	3,099	877	993	732
France	1,983	2,800	2,314	1,834	2,387
Germany, Fed.Rep.	2,289	1,079	12	1,977	228
Ireland	-	16	-	-	65
Netherlands	23,002	25,000	27,500[2]	34,350	38,700
Norway	394	-	-	-	-
Spain	50	234	104	142	560
UK (Engl. + Wales)	12,933	2,520	2,670	1,230	279
UK (Scotland)	1	-	-	-	1
USSR	-	-	-	-	-
Total	45,697	34,749	33,478	40,526	42,952

Country	1985	1986	1987	1988	1989	1990
Faroe Islands	-	-	-	-	-	28
Belgium	+	+	2	-	-	+
Denmark	1,477[2]	30,408[2]	27,368	33,202	34,474	30,594
France	1,881	3,801	2,197	1,523	4,576	2,538
Germany, Fed.Rep.	-	5	374	4,705	7,743	8,109
Ireland	100	703	15	481	12,645	17,887
Netherlands	33,550	40,750	69,400	43,560	43,582	111,900
Norway	-	-	-	-	-	-
Spain	275	137	148	150	14	16
UK (Engl. + Wales)	1,630	1,824	1,228	3,759	4,488	13,371
UK (N.Ireland)	-	-	-	-	-	-
UK (Scotland)	1	+	2	2,873	+	139
USSR	120	-	-	-	-	-
Unallocated + discards	-	-	-	-	28,368	7,614
Total	39,034	77,628	100,734	90,253	135,890	192,196

Country	1991	1992	1993	1994	1995	1996	1997[1]
Faroe Islands	-	-	-	-	-	-	-
Belgium	-	-	-	1	-	-	18
Denmark	28,888	18,984	16,978	41,605	28,300	43,330	60,412
France	1,230	1,198	1,001	-	-	-	27,201
Germany, Fed.Rep.	12,919	12,951	15,684	14,828	17,436	15,949	28,549
Ireland	19,074	15,568	16,363	15,281	58,011	38,455	43,624
Netherlands	104,107	109,197	157,110	92,903	116,126	114,692	81,464
Norway	-	-	-	-	-	-	-
Spain	113	106	54	29	25	33	-
UK (Engl. + Wales)	6,436	7,870	6,090	12,418	31,641	28,605	17,464
UK (N.Ireland)	2,026	1,690	587	119	-	-	1,093
UK (Scotland)	1,992	5,008	3,123	9,015	10,522	11,241	7,931
USSR	-	-	-	-	-	-	-
Unallocated + discards	24,541	15,563	4,010[3]	14,057	68,644	26,795	58,718
Total	201,326	188,135	221,000	200,256	330,705	279,100	326,474

[1]Provisional.
[2]Includes Sub-area VI.
[3]Includes a negative unallocated catch of -4,000 t.
[4]Includes 5 t from Jersey.

Table 6.2.5 Landings (t) of HORSE MACKEREL in Sub-area VIII by country. (Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984
Denmark	-	-	-	-	-
France	3,361	3,711	3.073	2,643	2,489
Netherlands	-	-	-	-	-[2]
Spain	34,134	36,362	19,610	25,580	23,119
UK (Engl. + Wales)	-	+	1	-	1
USSR	-	-	-	-	20
Total	37,495	40,073	22,683	28,223	25,629

Country	1985	1986	1987	1988	1989	1990
Denmark	-	446	3,283	2,793	6,729	5,726
France	4,305	3,534	3,983	4,502	4,719	5,082
Germany	-	-	-	-	-	-
Netherlands	-[2]	-[2]	-[2]	-	-	6,000
Spain	23,292	40,334	30,098	26,629	27,170	25,182
UK (Engl. + Wales)	143	392	339	253	68	6
USSR	-	656	-	-	-	-
Unallocated + discards	-	-	-	-	-	1,500
Total	27,740	45,362	37,703	34,177	38,686	43,496

Country	1991	1992	1993	1994	1995	1996	1997[1]
Denmark	1,349	5,778	1,955	-	340	140	729
France	6,164	6,220	4,010	28	-	7	8,690
Germany	80	62	-		-	-	-
Netherlands	12,437	9,339	19,000	7,272	-	14,187	2,944
Spain	23,733	27,688	27,921	25,409	28,349	29,428	31,081
UK (Engl. + Wales)	70	88	123	753	20	924	430
USSR	-	-	-		-	-	-
Unallocated + discards	2,563	5,011	700	2,038	-	3,583	-2,944
Total	46,396	54,186	53,709	35,500	28,709	48,269	40,930

[1]Preliminary.
[2]Included in Sub-area VII.

Table 6.4.1.1 Catch in numbers ('000) at age of WESTERN HORSE MACKEREL by quarter and by Division(s) in 1997.

1997	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	catch('000)	catch('000	catch('000	catch('000	catch('000	catch('000	catch ('000)
0	0	0	0	0	0	0	0
1	0	1	0	0	0	0	1
2	0	0	0	0	101,570	8,964	110,534
3	0	1	0	0	330,102	29,135	359,237
4	0	3	0	2,690	152,355	13,447	168,495
5	0	94	0	10,400	50,785	4,482	65,761
6	0	122	0	15,144	0	0	15,266
7	0	103	898	18,070	0	0	19,071
8	0	79	0	32,151	0	0	32,230
9	0	71	2,693	28,264	0	0	31,028
10	0	140	898	32,525	0	0	33,562
11	0	45	2,693	25,602	0	0	28,340
12	0	146	7,181	59,621	0	0	66,948
13	0	93	9,875	30,438	0	0	40,405
14	0	91	898	11,939	0	0	12,928
15+	0	212	19,750	145,827	0	0	165,789
Total	0	1,199	44,886	412,670	634,812	56,028	1,149,595
Tonnes	0	364	14,184	91,566	54,340	4,796	165,250

	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	catch('000)	catch('000	catch('000	catch('000	catch('000	catch('000	catch ('000)
0	0	0	0	0	0	0	0
1	0	2	0	0	2,068	933	3,003
2	0	0	0	1,604	70,319	31,715	103,638
3	0	2	0	8,028	26,886	12,126	47,043
4	0	9	0	16,074	0	0	16,083
5	0	331	0	21,828	2,068	933	25,160
6	0	429	0	23,853	0	0	24,282
7	0	362	155	24,688	2,068	933	28,206
8	0	276	0	31,810	0	0	32,086
9	0	247	466	22,958	0	0	23,671
10	0	488	155	17,929	0	0	18,572
11	0	156	466	20,613	0	0	21,235
12	0	510	1,241	27,321	0	0	29,072
13	0	325	1,707	11,542	0	0	13,574
14	0	319	155	2,556	0	0	3,031
15+	0	742	3,414	8,216	0	0	12,373
Total	0	4,198	7,760	239,021	103,410	46,639	401,027
Tonnes	0	1,274	2,452	46,874	6,308	2,845	59,753

	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	catch('000)	catch('000	catch('000	catch('000	catch('000	catch('000	catch ('000)
0	0	0	0	0	0	0	0
1	1	5	0	0	0	0	6
2	0	0	696	1,735	38,559	7,758	48,747
3	1	5	4,924	21,234	67,376	10,776	104,316
4	5	19	7,064	25,962	32,400	1,724	67,173
5	176	676	9,522	20,721	10,716	1,293	43,105
6	228	877	5,989	11,099	5,720	0	23,914
7	192	740	6,362	11,647	0	0	18,942
8	147	564	6,275	12,666	0	0	19,652
9	132	511	6,014	8,843	0	0	15,499
10	260	1,005	3,261	4,795	0	0	9,321
11	83	360	7,558	11,114	0	0	19,115
12	271	1,060	6,755	11,356	0	0	19,442
13	173	676	2,621	3,854	0	0	7,323
14	170	717	185	273	0	0	1,344
15+	395	1,519	4,266	6,273	0	0	12,453
Total	2,234	8,735	71,492	151,571	154,770	21,551	410,352
Tonnes	678	2,659	13,577	26,422	16,680	2,237	62,253

	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	catch('000)	catch('000	catch('000	catch('000	catch('000	catch('000	catch ('000)
0	0	0	0	0	0	0	0
1	3	113	18	0	494	91	721
2	0	0	0	1,180	149,647	3,384	154,211
3	3	113	18	23,222	165,730	3,567	192,654
4	13	455	72	25,846	110,733	1,280	138,399
5	504	16,299	2,577	11,152	66,225	1,463	98,220
6	653	21,135	3,342	3,805	19,634	1,280	49,849
7	550	17,841	2,821	3,805	28,173	1,463	54,654
8	419	13,595	2,150	5,708	16,022	823	38,717
9	376	12,169	1,924	0	19,308	183	33,961
10	744	24,080	3,808	0	6,046	91	34,769
11	237	7,703	1,218	0	0	0	9,158
12	776	25,122	3,972	2,361	494	91	32,817
13	494	16,010	2,532	0	0	0	19,036
14	486	15,736	2,488	0	0	0	18,710
15+	1,130	36,595	5,786	0	6,618	0	50,129
Total	6,389	206,968	32,726	77,079	589,124	13,719	926,005
Tonnes	1,939	62,813	9,932	10,717	68,115	1,799	155,315

Table 6.4.1.2 Catch in numbers, mean length and mean weight in catch and mean weight in stock of western horse mackerel 1997

	Catch in numbers	Mean length (cm)	Mean weight (kg)	
Age	(millions)	in catch	in catch	in stock
0	0.000	0.0	0.000	
1	3.730	18.6	0.039	
2	417.131	21.5	0.075	0.050
3	703.250	23.1	0.093	0.122
4	390.150	24.0	0.109	0.130
5	232.246	26.1	0.142	0.140
6	113.310	27.5	0.180	0.148
7	120.872	28.2	0.189	0.171
8	122.686	29.0	0.199	0.188
9	104.158	29.5	0.208	0.201
10	96.225	30.5	0.235	0.206
11	77.847	30.9	0.238	0.209
12	148.279	31.3	0.246	0.220
13	80.338	32.1	0.272	0.231
14	36.013	33.0	0.302	0.232
15+	240.744	33.0	0.289	0.233

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Table 6.4.2.1 Length (cm) at age of WESTERN HORSE MACKEREL by quarter and by Division(s) in 1997.

1997	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	21.0	0.0	0.0	0.0	0.0	21.0
2	0.0	0.0	0.0	0.0	21.5	21.5	21.5
3	0.0	25.0	0.0	0.0	22.9	22.9	22.9
4	0.0	26.0	0.0	25.0	23.0	23.0	23.0
5	0.0	28.5	0.0	26.1	25.5	25.5	25.6
6	0.0	29.8	0.0	26.9	0.0	0.0	27.0
7	0.0	30.3	28.5	27.5	0.0	0.0	27.6
8	0.0	30.9	0.0	29.0	0.0	0.0	29.0
9	0.0	30.9	31.2	29.6	0.0	0.0	29.7
10	0.0	31.2	34.5	30.1	0.0	0.0	30.2
11	0.0	32.3	35.2	30.8	0.0	0.0	31.2
12	0.0	31.9	34.4	31.3	0.0	0.0	31.6
13	0.0	33.1	34.4	31.2	0.0	0.0	32.0
14	0.0	33.9	34.5	31.8	0.0	0.0	32.0
15+	0.0	34.7	35.6	32.4	0.0	0.0	32.8
0-15+	0.0	31.8	34.7	30.8	22.9	22.9	26.2

	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	21.0	0.0	0.0	18.5	18.5	18.5
2	0.0	0.0	0.0	22.7	19.8	19.8	19.8
3	0.0	25.0	0.0	24.3	22.1	22.1	22.5
4	0.0	26.0	0.0	25.4	0.0	0.0	25.4
5	0.0	28.5	0.0	26.2	27.5	27.5	26.4
6	0.0	29.8	0.0	26.7	0.0	0.0	26.8
7	0.0	30.3	28.5	28.0	28.5	28.5	28.1
8	0.0	30.9	0.0	28.8	0.0	0.0	28.9
9	0.0	30.9	31.2	29.5	0.0	0.0	29.6
10	0.0	31.2	34.5	30.5	0.0	0.0	30.5
11	0.0	32.3	35.2	30.3	0.0	0.0	30.5
12	0.0	31.9	34.4	30.7	0.0	0.0	30.8
13	0.0	33.1	34.4	31.1	0.0	0.0	31.6
14	0.0	33.9	34.5	31.5	0.0	0.0	31.9
15+	0.0	34.7	35.6	31.4	0.0	0.0	32.8
0-15+	0.0	31.8	34.7	28.6	20.7	20.7	25.8

	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	length (cm)	length (cm	length (cm	length (cm	length (cm	length (cm	length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	21.0	21.0	0.0	0.0	0.0	0.0	21.0
2	0.0	0.0	23.0	23.2	22.3	22.2	22.3
3	25.0	25.0	24.2	24.2	23.2	23.1	23.4
4	26.0	26.0	25.1	25.0	24.2	24.0	24.6
5	28.5	28.5	26.1	26.1	25.2	24.8	25.9
6	29.8	29.8	27.1	27.0	27.0	0.0	27.2
7	30.3	30.3	27.9	27.9	0.0	0.0	28.0
8	30.9	30.9	28.5	28.5	0.0	0.0	28.6
9	30.9	31.0	29.2	29.2	0.0	0.0	29.3
10	31.2	31.2	30.2	30.2	0.0	0.0	30.3
11	32.3	32.6	30.2	30.2	0.0	0.0	30.3
12	31.9	32.0	30.7	30.3	0.0	0.0	30.6
13	33.1	33.1	31.0	31.0	0.0	0.0	31.3
14	33.9	34.2	31.5	31.5	0.0	0.0	33.2
15+	34.7	34.7	31.3	31.3	0.0	0.0	31.8
0-15+	31.8	31.9	28.1	27.3	23.5	22.9	25.9

	IIa	IVa	VIa	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	21.0	21.0	21.0	0.0	18.5	18.5	19.0
2	0.0	0.0	0.0	23.5	22.4	21.2	22.3
3	25.0	25.0	25.0	24.2	23.4	22.8	23.5
4	26.0	26.0	26.0	24.9	24.8	24.9	24.9
5	28.5	28.5	28.5	26.1	25.8	25.8	26.4
6	29.8	29.8	29.8	26.5	26.6	26.4	28.2
7	30.3	30.3	30.3	28.0	27.4	27.7	28.6
8	30.9	30.9	30.9	28.5	27.9	28.5	29.2
9	30.9	30.9	30.9	0.0	28.2	29.0	29.3
10	31.2	31.2	31.2	0.0	28.9	30.5	30.8
11	32.3	32.3	32.3	0.0	0.0	0.0	32.3
12	31.9	31.9	31.9	27.5	30.5	30.5	31.6
13	33.1	33.1	33.1	0.0	0.0	0.0	33.1
14	33.9	33.9	33.9	0.0	0.0	0.0	33.9
15+	34.7	34.7	34.7	0.0	29.5	0.0	34.0
0-15+	31.8	31.8	31.8	25.4	24.4	24.3	26.4

Table 6.4.2.2 Weight (g) at age of WESTERN HORSE MACKEREL by quarter and by Division(s) in 1997.

1997	IIa	IVa	Via	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)
0	0	0	0	0	0	0	0
1	0	100	0	0	0	0	100
2	0	0	0	0	69	69	69
3	0	150	0	0	85	85	85
4	0	175	0	107	87	87	87
5	0	218	0	127	120	120	121
6	0	251	0	141	0	0	142
7	0	260	178	155	0	0	156
8	0	290	0	177	0	0	177
9	0	277	239	193	0	0	197
10	0	288	291	202	0	0	205
11	0	325	309	222	0	0	230
12	0	302	287	229	0	0	235
13	0	329	320	228	0	0	251
14	0	341	308	249	0	0	254
15+	0	388	344	260	0	0	270
0-15+	0	303	316	222	86	86	144

	IIa	IVa	Via	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)
0	0	0	0	0	0	0	0
1	0	100	0	0	33	33	33
2	0	0	0	101	51	51	52
3	0	150	0	122	71	71	80
4	0	175	0	146	0	0	146
5	0	218	0	148	129	129	147
6	0	251	0	162	0	0	164
7	0	260	178	180	200	200	183
8	0	290	0	191	0	0	192
9	0	277	239	205	0	0	206
10	0	288	291	216	0	0	218
11	0	325	309	216	0	0	219
12	0	302	287	225	0	0	229
13	0	329	320	261	0	0	270
14	0	341	308	242	0	0	256
15+	0	388	344	233	0	0	273
0-15+	0	303	316	192	60	60	146

	IIa	IVa	Via	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	weight (g)	weight (g)	weight (g)	weight (g)	weight (g)	weight (g)	weight(g)
0	0	0	0	0	0	0	0
1	100	100	0	0	0	0	100
2	0	0	104	108	95	94	96
3	150	150	123	121	105	107	109
4	175	175	139	134	115	116	125
5	218	218	156	151	132	125	148
6	251	251	173	171	145	0	169
7	260	260	183	185	0	0	188
8	290	290	197	195	0	0	199
9	277	278	214	214	0	0	217
10	288	288	230	230	0	0	238
11	325	326	228	228	0	0	231
12	302	304	233	226	0	0	234
13	329	329	238	238	0	0	249
14	341	346	254	254	0	0	314
15+	388	388	237	237	0	0	260
0-15+	304	304	190	175	108	104	152

	IIa	IVa	Via	VIIb,c,j,k	VIIa,e,f,g,h	VIIIa,b,d,e	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)
0	0	0	0	0	0	0	0
1	100	100	100	0	54	54	63
2	0	0	0	113	88	85	89
3	150	150	150	119	100	101	102
4	175	175	175	131	120	141	123
5	218	218	218	141	135	157	152
6	251	251	251	164	153	170	204
7	260	260	260	191	165	187	204
8	290	290	290	190	169	203	223
9	277	277	277	0	171	204	216
10	288	288	288	0	193	271	272
11	325	325	325	0	0	0	325
12	302	302	302	173	209	209	291
13	329	329	329	0	0	0	329
14	341	341	341	0	0	0	341
15+	388	388	388	0	186	0	361
0-15+	304	303	303	139	116	131	168

Table 6.5.2.1 Western Horse mackerel catch numbers at age.

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Run title : Western Horse Mackerel 1997 W.G.

At  6/10/1998  13:39


      Table  1    Catch numbers at age                              Numbers*10**-3
      YEAR,        1982,    1983,    1984,    1985,    1986,    1987,

      AGE
        0,            0,       0,       0,       0,       0,       0,
        1,         2523,    5668,       0,    1267,       0,      83,
        2,        14320,    1627,  183682,    3802,       0,     414,
        3,        91566,   23595,    3378,  467741,    1120,       0,
        4,         7825,   38374,   27621,    3462,  489397,    2476,
        5,         8968,   11005,  114001,   32441,    6316,  748405,
        6,         7979,   31942,   17009,   77862,   47149,    1730,
        7,         6013,   37775,   29105,    9808,   79428,   34886,
        8,         1122,   12854,   25890,   12545,   18609,   76224,
        9,          281,    2360,   11230,    4809,   15328,    9854,
       10,         1122,    3948,    3121,    7155,   11052,    8015,
       11,         4473,    2428,       0,     263,    2255,   16252,
       12,        12560,   12204,     486,     659,     746,    7484,
       13,        19489,   17142,    1337,    2888,     619,    1173,
       14,        13205,   27505,    3866,     970,     211,     168,
      +gp,         5579,   33335,   38732,   27005,   37295,   27613,
0     TOTALNUM,  197025,  261762,  459458,  652677,  709525,  934777,
      TONSLAND,   41588,   64862,   73625,   80521,  105665,  156247,
      SOPCOF %,      99,      99,     101,      99,      98,     100,


      Table  1    Catch numbers at age                              Numbers*10**-3
      YEAR,        1988,    1989,    1990,    1991,    1992,    1993,    1994,    1995,    1996,    1997,

      AGE
        0,          767,       0,       0,    3230,   12420,       0,    2315,       0,       0,       0,
        1,        23975,       0,   19117,   19570,   83830,   94250,   15324,   50843,    4036,    3726,
        2,         5354,       0,   42191,   47240,   24040,   49520,  796606,  411412,  615759,  417131,
        3,         1839,   18860,  130153,   13980,   66180,    7700,  104631,  382838,  841304,  703250,
        4,         3856,   16604,   57561,  187410,   50210,   52870,   49463,  198181,  157053,  390150,
        5,        16616,    4821,   31195,  126310,  243720,   83770,   40466,   52812,   67924,  232246,
        6,       824940,   13169,    9883,   68330,  110620,  307370,   26961,   85565,   45939,  113310,
        7,        10613, 1159554,   19305,   19000,   42840,  124050,  205842,   26425,   48597,  120872,
        8,        34963,   10940, 1297370,   21090,   14202,   65790,   87767,  230028,   49091,  122686,
        9,        59452,   53909,   34673, 1173940,   17930,   25250,   37045,  107838,   44193,  104158,
       10,         8531,   75496,   66058,   21140, 1063910,    3250,   40453,   95799,   48439,   96225,
       11,        14301,   12629,   95505,   13060,   12000, 1177060,   21847,   58051,   89046,   77847,
       12,        15158,   21975,   14040,   51200,   22750,    6420,  909325,   62531,   65209,  148279,
       13,         4537,   12471,   32496,    9710,   69970,   16110,    9861, 1044929,   54915,   80338,
       14,         4285,    8162,   16935,    9000,   12110,   52610,   14411,   38647,  343831,   36013,
      +gp,        28378,   16468,   53023,   49400,   32200,   33490,   37138,  149957,  165073,  240744,
0     TOTALNUM, 1057565, 1425058, 1919505, 1833610, 1878932, 2099510, 2399455, 2995856, 2640409, 2886975,
      TONSLAND,  188100,  268867,  373463,  333600,  368200,  432000,  347842,  512995,  396448,  442571,
      SOPCOF %,      95,      97,     100,     102,      99,     100,      90,     101,     101,     100,
1
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Table 6.5.2.2 Western Horse mackerel Catch weights at age.

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    Run title : Western Horse Mackerel 1997 W.G.

    At  6/10/1998  13:39


        Table  2    Catch weights at age (kg)
        YEAR,       1982,    1983,    1984,    1985,    1986,    1987,

        AGE
          0,        .0150,   .0150,   .0150,   .0150,   .0150,   .0150,
          1,        .0540,   .0390,   .0340,   .0290,   .0290,   .0680,
          2,        .0900,   .1130,   .0730,   .0450,   .0450,   .0670,
          3,        .1420,   .1240,   .0890,   .0870,   .1100,   .1100,
          4,        .1780,   .1680,   .1300,   .1500,   .1070,   .1550,
          5,        .2270,   .2290,   .1760,   .1560,   .1710,   .1430,
          6,        .2730,   .2470,   .2160,   .1990,   .1960,   .1740,
          7,        .2760,   .2820,   .2450,   .2430,   .2230,   .1980,
          8,        .2920,   .2810,   .2780,   .2560,   .2510,   .2490,
          9,        .3050,   .2540,   .2620,   .2940,   .2960,   .2640,
         10,        .3690,   .2600,   .2590,   .2570,   .2800,   .3210,
         11,        .3480,   .3000,   .2550,   .2410,   .3190,   .3360,
         12,        .3480,   .3100,   .3440,   .2510,   .2870,   .2440,
         13,        .3480,   .3150,   .2320,   .3140,   .3450,   .3280,
         14,        .3560,   .3110,   .3060,   .3460,   .2600,   .2450,
        +gp,        .3660,   .3320,   .3080,   .3210,   .3600,   .3730,
0     SOPCOFAC,     .9908,   .9886,  1.0126,   .9945,   .9834,   .9964,


        Table  2    Catch weights at age (kg)
        YEAR,       1988,    1989,    1990,    1991,    1992,    1993,    1994,    1995,    1996,    1997,

        AGE
          0,        .0150,   .0120,   .0150,   .0120,   .0080,   .0100,   .0210,   .0150,   .0150,   .0150,
          1,        .0310,   .0500,   .0320,   .0310,   .0140,   .0330,   .0370,   .0380,   .0590,   .0390,
          2,        .0750,   .0750,   .0310,   .0460,   .0920,   .0830,   .0520,   .0520,   .0780,   .0750,
          3,        .1140,   .1490,   .0900,   .1130,   .1170,   .1200,   .1060,   .0730,   .0900,   .0930,
          4,        .1320,   .1420,   .1240,   .1250,   .1390,   .1260,   .1240,   .0890,   .1250,   .1090,
          5,        .1470,   .1420,   .1260,   .1480,   .1430,   .1420,   .1580,   .1260,   .1410,   .1420,
          6,        .1570,   .2200,   .1290,   .1410,   .1570,   .1540,   .1530,   .1300,   .1550,   .1800,
          7,        .2400,   .1660,   .2020,   .1440,   .1630,   .1630,   .1670,   .1700,   .1660,   .1890,
          8,        .3040,   .2580,   .1830,   .1870,   .1720,   .1830,   .1940,   .1760,   .1770,   .1990,
          9,        .3350,   .3270,   .2270,   .1850,   .2350,   .1990,   .1990,   .2000,   .1910,   .2080,
         10,        .3860,   .3300,   .3200,   .2150,   .2220,   .1770,   .2800,   .2040,   .2060,   .2350,
         11,        .4340,   .3810,   .3280,   .3030,   .2880,   .2380,   .2750,   .2220,   .2240,   .2380,
         12,        .4040,   .4000,   .3550,   .3230,   .3060,   .3080,   .2400,   .2150,   .2330,   .2460,
         13,        .3310,   .4210,   .3990,   .3540,   .3590,   .3270,   .3260,   .2460,   .2290,   .2720,
         14,        .3920,   .4480,   .3880,   .3650,   .3930,   .3760,   .3420,   .2370,   .2800,   .3020,
        +gp,        .4240,   .5160,   .3790,   .3300,   .4010,   .4210,   .3830,   .2980,   .3320,   .2890,
0     SOPCOFAC,     .9511,   .9685,  1.0033,  1.0168,   .9859,   .9973,   .9000,  1.0059,  1.0055,  1.0022,
1
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Table 6.5.2.3 Western horse mackerel stock weights at age

Run title : Western Horse Mackerel 1997 W.G.

At 6/10/1998 13:39

Table 3 Stock weights at age (kg) YEAR,	1982,	1983,	1984,	1985,	1986,	1987,
AGE						
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,
3,	.0800,	.0800,	.0770,	.0810,	.0800,	.0800,
4,	.2070,	.1710,	.1220,	.1480,	.1050,	.1050,
5,	.2320,	.2270,	.1550,	.1400,	.1340,	.1260,
6,	.2690,	.2570,	.2010,	.1930,	.1690,	.1500,
7,	.2800,	.2760,	.2230,	.2360,	.1950,	.1710,
8,	.2920,	.2700,	.2530,	.2420,	.2420,	.2180,
9,	.3050,	.2430,	.2460,	.2890,	.2920,	.2540,
10,	.3690,	.3900,	.3380,	.2470,	.2620,	.2810,
11,	.3440,	.3050,	.3000,	.3000,	.3000,	.2910,
12,	.3480,	.3090,	.3000,	.3000,	.3000,	.2970,
13,	.3480,	.3110,	.3000,	.3250,	.3000,	.3030,
14,	.3610,	.3120,	.3050,	.3250,	.3000,	.3030,
+gp,	.3640,	.3100,	.2850,	.3030,	.3460,	.3390,

Table 3 Stock weights at age (kg) YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,
3,	.0800,	.0800,	.0800,	.0800,	.0800,	.0800,	.0800,	.0660,	.0950,	.1220,
4,	.1050,	.1050,	.1050,	.1210,	.1050,	.1050,	.1050,	.1190,	.1180,	.1300,
5,	.1260,	.1030,	.1270,	.1370,	.1330,	.1530,	.1470,	.0960,	.1290,	.1400,
6,	.1410,	.1310,	.1350,	.1430,	.1510,	.1660,	.1850,	.1520,	.1480,	.1480,
7,	.1430,	.1590,	.1240,	.1440,	.1500,	.1730,	.1690,	.1660,	.1720,	.1710,
8,	.2170,	.1270,	.1540,	.1500,	.1580,	.1720,	.1910,	.1780,	.1830,	.1880,
9,	.2740,	.2100,	.1740,	.1820,	.1600,	.1700,	.1910,	.1870,	.1850,	.2010,
10,	.3050,	.2520,	.2820,	.1890,	.1820,	.2060,	.1900,	.1970,	.2020,	.2060,
11,	.3370,	.2630,	.2720,	.2660,	.2920,	.2110,	.1970,	.1870,	.2060,	.2090,
12,	.3520,	.3020,	.4040,	.2950,	.2110,	.2580,	.2310,	.2290,	.2170,	.2200,
13,	.3610,	.4110,	.4040,	.3490,	.2450,	.2880,	.2700,	.2180,	.2210,	.2310,
14,	.3520,	.3830,	.4040,	.3610,	.3610,	.3380,	.2700,	.2720,	.2370,	.2320,
+gp,	.3900,	.3580,	.4040,	.3810,	.4030,	.4050,	.3380,	.3480,	.2730,	.2330,

1

Table 6.5.2.4 Western horse mackerel proportion mature at age.

Run title : Western Horse Mackerel 1997 W.G.

At 6/10/1998 13:50

Table 5 Proportion mature at age YEAR,	1982,	1983,	1984,	1985,	1986,	1987,
AGE						
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.4000,	.3000,	.1000,	.1000,	.1000,	.1000,
3,	.8000,	.7000,	.6000,	.4000,	.4000,	.4000,
4,	1.0000,	1.0000,	.8500,	.8000,	.6000,	.6000,
5,	1.0000,	1.0000,	1.0000,	.9500,	.9000,	.8000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,
3,	.4000,	.4000,	.4000,	.4000,	.4000,	.4000,	.4000,	.4000,	.4000,	.4000,
4,	.6000,	.6000,	.6000,	.6000,	.6000,	.6000,	.6000,	.6000,	.6000,	.6000,
5,	.8000,	.8000,	.8000,	.8000,	.8000,	.8000,	.8000,	.8000,	.8000,	.8000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

1

Table 6.5.3.1 Western Horse Mackerel . Summary results of Bayesian stock assessment. Percentiles of the distribution of fishing mortality relative to natural mortality (Population mean fishing mortality over ages 4 to 14 divided by natural mortality), spawning stock size, and recruitment by year from 1982-1996. Percentiles calculated from 1000 drawn parameter vectors from the Markov Chain.

a. Fishing Mortality relative to Natural Mortality (F 4-14w/M)

Percentile	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
5	0.22	0.31	0.40	0.26	0.21	0.32	0.38	0.56	0.75	0.82	0.92	1.25	1.10	1.80	0.95	1.98
25	0.36	0.51	0.63	0.41	0.33	0.49	0.57	0.84	1.09	1.17	1.29	1.73	1.53	2.49	1.34	2.86
50	0.51	0.71	0.86	0.55	0.44	0.64	0.74	1.08	1.41	1.50	1.64	2.18	1.93	3.15	1.69	3.67
75	0.63	0.87	1.05	0.67	0.54	0.77	0.90	1.30	1.69	1.79	1.98	2.65	2.37	3.88	2.12	4.66
95	0.75	1.05	1.26	0.81	0.64	0.91	1.06	1.56	2.04	2.17	2.43	3.31	3.00	5.13	2.88	6.70
Expectation	0.50	0.69	0.84	0.54	0.43	0.63	0.73	1.07	1.39	1.49	1.64	2.20	1.97	3.25	1.77	3.88

b. Spawning Stock Size (Thousand t at spawning time)

Percentile	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
5	679	756	796	1318	889	2283	2812	1451	2562	2550	2074	2138	1785	1435	1265	713
25	743	838	870	1446	1065	2500	3087	1987	2827	2825	2322	2420	2053	1718	1558	945
50	812	909	948	1577	1275	2699	3318	2422	3054	3073	2559	2692	2342	2000	1857	1173
75	920	1030	1058	1763	1607	2968	3634	2827	3337	3363	2825	2998	2645	2306	2182	1417
95	1154	1281	1287	2121	2250	3483	4239	3414	3864	3917	3346	3609	3268	2868	2819	1917
Expectation	851	951	982	1632	1394	2771	3400	2423	3123	3137	2613	2755	2399	2057	1922	1221

c. Recruitment (Millions of fish aged 0)

Percentile	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
5	21225	676	938	1621	1442	2377	919	1045	790	1074	2531	2919	782	796	772	764
25	23413	791	1147	1967	1635	2609	1101	1242	965	1228	2826	3353	1226	1231	1283	1187
50	25734	911	1334	2275	1810	2824	1261	1420	1126	1368	3097	3770	1679	1632	1734	1698
75	29582	1072	1597	2700	2054	3110	1466	1634	1314	1533	3408	4240	2318	2259	2383	2345
95	37744	1408	2135	3527	2508	3672	1850	2040	1680	1847	3994	5187	3872	3816	3836	3545
Expectation	27176	961	1412	2394	1877	2899	1315	1470	1169	1406	3161	3866	1907	1871	1933	1873

d. Natural Mortality (all ages) (approx.)

Percentile	M
5	0.052
25	0.055
50	0.063
75	0.077
95	0.103
Expectation	0.070

Table 6.6.1 Western Horse Mackerel. Catch option table, calculated as expectation and percentiles of Bayes posterior distributions. (a) SSB, catch and F/M in 1998, (b) SSB in 1999, for F=M or catch = 50 to 400Kt in 1999; (c) SSB in 2000, for F=M or catch = 50 to 400Kt in 1999 and 2000; (d) Catch corresponding to F=M; (e) F/M in 1999; (f) F/M in 2000

(a)

	1998				Estimated Risk in 1998	
	Expected	Percentiles				
		25%	50%	75%	P(SSB<500,000t)	P(SSB<SSB(1983)
SSB (Thousand t)	1032	728	972	1251		
Catch (Thousand t)	400	*no uncertainty admitted*			0.06	0.46
F(4-14,w)/M	5.49	3.88	5.07	6.52		

(b)

Catch (Thousand t)	SSB in 1999 (Kt)				Estimated Risk in 1999	
	Expected	Percentiles				
		25%	50%	75%	P(SSB<500,000t)	P(SSB<SSB(1983)
Catch for F=M	940	620	877	1169	0.00	0.00
50	945	618	885	1174	0.14	0.55
100	927	601	867	1155	0.16	0.57
200	889	563	831	1118	0.19	0.60
300	849	521	791	1080	0.23	0.64
400	807	477	749	1040	0.27	0.68

(c)

Catch (Thousand t)	SSB in 2000 (Kt)				Estimated Risk in 2000	
	Expected	Percentiles				
		25%	50%	75%	P(SSB<500,000t)	P(SSB<SSB(1983)
Catch for F=M	1015	672	951	1262	0.00	0.00
50 Kt in 1999 and 2000	1032	671	967	1297	0.11	0.47
100 Kt in 1999 and 2000	972	612	905	1235	0.16	0.53
200 Kt in 1999 and 2000	849	489	781	1112	0.26	0.63
300 Kt in 1999 and 2000	727	365	660	986	0.36	0.74
400 Kt in 1999 and 2000	611	239	530	856	0.47	0.83

(d)

Catch (Thousand t)	Catch for F=M			
	Expected	Percentiles		
		25%	50%	75%
1999	66	48	61	79
2000	69	52	65	82

(e)

Fishing Mortality Relative to Natural Mortality in 1999, for catch options in 1999 = 50 to 400 000t and catch in 1998=400 000t

Catch in 1999 (Thous. t)	Expected	Percentiles		
		25%	50%	75%
50	0.75	0.50	0.67	0.89
100	1.54	1.01	1.37	1.83
200	3.33	2.10	2.88	3.92
300	5.39	3.29	4.55	6.41
400	7.67	4.60	6.47	9.34

(f)

Fishing Mortality Relative to Natural Mortality in 2000, for catch options in 1999 -2000 = 50 to 400 000t and catch in 1998=400 000t

Catch in 1999 and 2000	Expected	Percentiles		
(Thousand t)		25%	50%	75%
50	0.69	0.47	0.62	0.82
100	1.52	0.98	1.32	1.79
200	3.85	2.21	3.10	4.40
300	7.21	3.79	5.52	8.71
400	10.70	5.87	9.12	14.92

Table 6.8.1.1. Western Horse Mackerel: Input to the ADAPT assessment. **a.**: Catch in numbers. **b.:** Mean weight at age in the catch.

a. Catch in numbers (canum)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	0	0	0	0	0	0	767	0	0	3230	12420	0	2315	0	0	0
1	2523	5668	0	1267	0	83	23975	0	19117	19570	83830	94250	15324	50843	4036	3726
2	14320	1627	183682	3802	0	414	5354	0	42191	47240	24040	49520	796606	411412	615759	417131
3	91566	23595	3378	467741	1120	0	1839	18860	130153	13980	66180	7700	104631	382838	841304	703245
4	7825	38374	27621	3462	489397	2476	3856	16604	57561	187410	50210	52870	49463	198181	157053	390131
5	8968	11005	114001	32441	6316	748405	16616	4821	31195	126310	243720	83770	40466	52812	67924	231570
6	7979	31942	17009	77862	47149	1730	824940	13169	9883	68330	110620	307370	26961	85565	45939	112433
7	6013	37775	29105	9808	79428	34886	10613	1159554	19305	19000	42840	124050	205842	26425	48597	120131
8	1122	12854	25890	12545	18609	76224	34963	10940	1297370	21090	14202	65790	87767	230028	49091	122121
9	281	2360	11230	4809	15328	9854	59452	53909	34673	1173940	17930	25250	37045	107838	44193	103944
10	1122	3948	3121	7155	11052	8015	8531	75496	66058	21140	1063910	3250	40453	95799	48439	95516
11	4473	2428	0	263	2255	16252	14301	12629	95505	13060	12000	1177060	21847	58051	89046	79553
12	12560	12204	486	659	746	7484	15158	21975	14040	51200	22750	6420	909325	62531	65209	148103
13	19489	17142	1337	2888	619	1173	4537	12471	32496	9710	69970	16110	9861	1044929	54915	80255
14	13205	27505	3866	970	211	168	4285	8162	16935	9000	12110	52610	14411	38647	343831	38548
15+	5579	33335	38732	27005	37295	27613	28378	16468	53023	49400	32200	33490	37138	149957	165073	239225

b. Mean weight at age in the catch (kg) (weca)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.012	0.015	0.012	0.008	0.010	0.021	0.015	0.015	0.017
1	0.054	0.039	0.034	0.029	0.029	0.068	0.031	0.050	0.032	0.031	0.014	0.033	0.037	0.038	0.059	0.039
2	0.090	0.113	0.073	0.045	0.045	0.067	0.075	0.075	0.031	0.046	0.092	0.083	0.052	0.052	0.078	0.075
3	0.142	0.124	0.089	0.087	0.110	0.110	0.114	0.149	0.090	0.113	0.117	0.120	0.106	0.073	0.090	0.093
4	0.178	0.168	0.130	0.150	0.107	0.155	0.132	0.142	0.124	0.125	0.139	0.126	0.124	0.089	0.125	0.109
5	0.227	0.229	0.176	0.156	0.171	0.143	0.147	0.142	0.126	0.148	0.143	0.142	0.158	0.126	0.141	0.142
6	0.273	0.247	0.216	0.199	0.196	0.174	0.157	0.220	0.129	0.141	0.157	0.154	0.153	0.130	0.155	0.180
7	0.276	0.282	0.245	0.243	0.223	0.198	0.240	0.166	0.202	0.144	0.163	0.163	0.167	0.170	0.166	0.189
8	0.292	0.281	0.278	0.256	0.251	0.249	0.304	0.258	0.183	0.187	0.172	0.183	0.194	0.176	0.177	0.199
9	0.305	0.254	0.262	0.294	0.296	0.264	0.335	0.327	0.227	0.185	0.235	0.199	0.199	0.200	0.191	0.208
10	0.369	0.260	0.259	0.257	0.280	0.321	0.386	0.330	0.320	0.215	0.222	0.177	0.280	0.204	0.206	0.235
11	0.348	0.300	0.255	0.241	0.319	0.336	0.434	0.381	0.328	0.303	0.288	0.238	0.275	0.222	0.224	0.238
12	0.348	0.310	0.344	0.251	0.287	0.244	0.404	0.400	0.355	0.323	0.306	0.308	0.240	0.215	0.233	0.246
13	0.348	0.315	0.232	0.314	0.345	0.328	0.331	0.421	0.399	0.354	0.359	0.327	0.326	0.246	0.229	0.272
14	0.356	0.311	0.306	0.346	0.260	0.245	0.392	0.448	0.388	0.365	0.393	0.376	0.342	0.237	0.280	0.302
15+	0.366	0.332	0.308	0.321	0.360	0.373	0.424	0.516	0.379	0.330	0.401	0.421	0.383	0.298	0.332	0.289

Table 6.8.1.1. (continued) Western Horse Mackerel: Input to the ADAPT assessment. **c.:** Mean weight at age in the stock. **d.:** Proportion of fish mature at the start of the year.

c. Mean weight at age in the stock (kg) (west)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
3	0.080	0.080	0.077	0.081	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.066	0.095	0.080
4	0.207	0.171	0.122	0.148	0.105	0.105	0.105	0.105	0.105	0.121	0.105	0.105	0.105	0.119	0.118	0.112
5	0.232	0.227	0.155	0.140	0.134	0.126	0.126	0.103	0.127	0.137	0.133	0.153	0.147	0.096	0.129	0.124
6	0.269	0.257	0.201	0.193	0.169	0.150	0.141	0.131	0.135	0.143	0.151	0.166	0.185	0.152	0.148	0.162
7	0.280	0.276	0.223	0.236	0.195	0.171	0.143	0.159	0.124	0.144	0.150	0.173	0.169	0.166	0.172	0.169
8	0.292	0.270	0.253	0.242	0.242	0.218	0.217	0.127	0.154	0.150	0.158	0.172	0.191	0.178	0.183	0.184
9	0.305	0.243	0.246	0.289	0.292	0.254	0.274	0.210	0.174	0.182	0.160	0.170	0.191	0.187	0.185	0.188
10	0.369	0.390	0.338	0.247	0.262	0.281	0.305	0.252	0.282	0.189	0.182	0.206	0.190	0.197	0.202	0.208
11	0.344	0.305	0.300	0.300	0.300	0.291	0.337	0.263	0.272	0.266	0.292	0.211	0.197	0.187	0.206	0.197
12	0.348	0.309	0.300	0.300	0.300	0.297	0.352	0.302	0.404	0.295	0.211	0.258	0.231	0.229	0.217	0.226
13	0.348	0.311	0.300	0.325	0.300	0.303	0.361	0.411	0.404	0.349	0.245	0.288	0.270	0.218	0.221	0.236
14	0.361	0.312	0.305	0.325	0.300	0.303	0.352	0.383	0.404	0.361	0.361	0.338	0.270	0.272	0.237	0.260
15+	0.364	0.310	0.285	0.303	0.346	0.339	0.390	0.358	0.404	0.381	0.403	0.405	0.338	0.348	0.273	0.256

d. Proportion of fish mature (matprop)

Age	1982	1983	1984	1985	1986	1987	1988-2004
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
2	0.40	0.30	0.10	0.10	0.10	0.10	0.10
3	0.80	0.70	0.60	0.40	0.40	0.40	0.40
4	1	1	0.85	0.80	0.60	0.60	0.60
5	1	1	1	0.95	0.90	0.80	0.80
6	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1
15+	1	1	1	1	1	1	1

Table 6.8.1.2. Western Horse Mackerel: Historical assessment (output from ADAPT). **a.**: Fishing mortality. Stock numbers weights mean weighted F.

a. Fishing mortality

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	0	0	0	0	0	0	0.000	0	0	0.002	0.003	0	0.001	0	0	0.001
1	0.001	0.000	0	0.000	0	0	0.005	0	0.009	0.012	0.047	0.025	0.003	0.014	0.003	0.012
2	0.007	0.001	0.004	0.002	0	0.000	0.002	0	0.023	0.025	0.017	0.033	0.290	0.113	0.225	0.493
3	0.017	0.013	0.002	0.011	0.001	0	0.001	0.008	0.039	0.009	0.042	0.006	0.087	0.208	0.332	0.405
4	0.006	0.008	0.018	0.002	0.013	0.002	0.002	0.005	0.028	0.069	0.038	0.040	0.048	0.223	0.117	0.239
5	0.007	0.010	0.029	0.025	0.005	0.024	0.014	0.003	0.011	0.074	0.114	0.078	0.037	0.063	0.105	0.239
6	0.007	0.030	0.018	0.023	0.044	0.002	0.032	0.013	0.007	0.030	0.081	0.194	0.031	0.098	0.068	0.239
7	0.010	0.041	0.033	0.012	0.028	0.039	0.011	0.054	0.022	0.015	0.022	0.117	0.182	0.036	0.070	0.239
8	0.003	0.025	0.034	0.017	0.028	0.033	0.048	0.014	0.075	0.028	0.013	0.041	0.107	0.300	0.083	0.239
9	0.012	0.007	0.026	0.008	0.025	0.018	0.030	0.092	0.052	0.086	0.029	0.027	0.028	0.176	0.081	0.239
10	0.050	0.222	0.011	0.019	0.020	0.015	0.018	0.047	0.147	0.039	0.099	0.006	0.053	0.088	0.106	0.239
11	0.093	0.137	0	0.001	0.007	0.036	0.033	0.032	0.073	0.037	0.026	0.144	0.050	0.095	0.105	0.239
12	0.057	0.369	0.035	0.058	0.004	0.028	0.040	0.061	0.043	0.048	0.079	0.017	0.149	0.185	0.139	0.239
13	0.065	0.097	0.059	0.280	0.067	0.007	0.020	0.040	0.114	0.036	0.081	0.070	0.031	0.241	0.232	0.239
14	0.037	0.116	0.027	0.052	0.028	0.022	0.029	0.044	0.067	0.040	0.054	0.077	0.079	0.152	0.110	0.239
15+	0.037	0.116	0.027	0.052	0.028	0.022	0.029	0.044	0.067	0.040	0.054	0.077	0.079	0.152	0.110	0.239
mean F5-14																
unweighted	0.034	0.105	0.027	0.050	0.026	0.022	0.028	0.040	0.061	0.043	0.060	0.077	0.075	0.143	0.110	0.239
weighted	0.018	0.037	0.028	0.020	0.024	0.024	0.031	0.048	0.063	0.068	0.082	0.116	0.108	0.176	0.104	0.239
mean F2-4u	0.010	0.007	0.008	0.005	0.005	0.001	0.001	0.004	0.030	0.034	0.032	0.027	0.142	0.181	0.225	0.379

Table 6.8.1.2. (continued) Western Horse Mackerel: Historical assessment (output from ADAPT). **b.:** Population numbers. **c.:** Median spawning stock biomass. **d.:** Spawning Stock Biomass as estimated from egg surveys (observed) and as fitted to these observations (expected). **e.:** Total landings. **f.:** Recruitment at age 1.

b. Population numbers (thousands)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	73377	2843	4053	6294	4200	5781	2728	2823	2145	2296	4713	5621	4504	1555	378	3627
1	2530	63156	2447	3489	5417	3615	4975	2347	2430	1846	1973	4045	4838	3875	1338	325
2	2299	2175	54354	2106	3002	4663	3111	4260	2020	2074	1571	1620	3394	4150	3288	1148
3	6035	1965	1871	46613	1809	2583	4013	2673	3667	1700	1741	1330	1349	2186	3191	2261
4	1388	5110	1670	1607	39686	1556	2224	3452	2283	3035	1450	1437	1137	1064	1527	1970
5	1342	1187	4362	1412	1380	33705	1337	1910	2956	1912	2439	1201	1188	933	733	1169
6	1180	1147	1012	3649	1185	1182	28317	1135	1640	2515	1528	1874	957	985	754	568
7	669	1008	958	855	3069	976	1016	23608	965	1402	2102	1213	1329	798	769	607
8	410	570	833	797	727	2568	808	864	19246	813	1189	1769	929	953	663	617
9	25	352	479	693	675	608	2139	663	734	15363	680	1010	1462	719	608	525
10	25	21	300	402	592	566	515	1786	521	599	12137	569	846	1224	519	482
11	54	20	15	256	339	499	480	435	1468	387	496	9461	486	691	965	402
12	246	42	15	13	220	290	414	400	363	1175	321	416	7054	398	541	748
13	335	200	25	13	10	188	242	343	324	299	964	255	352	5230	285	405
14	391	270	156	21	8	8	161	204	283	249	248	765	205	294	3536	195
15+	165	327	1566	571	1461	1360	1067	413	887	1365	661	487	528	1141	1698	1208

c. Spawning stock biomass (tonnes)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
median	2118211	2396613	2601480	3617846	4814485	5649036	6434475	5745022	5358954	5352430	4365948	4113464	3469605	2968985	2799067	1626713

d. Observed and expected spawning stock biomass (from egg survey estimates)(tonnes)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
observed											2210000			1710000			*1368000*
expected	1941728	2189600	2372595	3304681	4398250	5152663	5851241	5202140	4810152	4767621	3854716	3589389	2976209	2490533	2290680	1285355	880918

e. Landings (tonnes) with an F constraint for 1998 (F98=F97)

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
41588	64862	73625	80521	105665	156247	188100	268867	373463	333600	368200	432000	347842	512995	396448	442571	*257230*

f. Recruitment at age 1 (millions)

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
2530	63156	2447	3489	5417	3615	4975	2347	2430	1846	1973	4045	4838	3875	1338	325	*3627*
															Geometric mean over yearclasses 1981 and 1983-1992	**3121**

Numbers in italics are preliminary estimates!

Tab 6.8.3.1

Options for 1998 1999-2003	F98 = F97						Catch 98 = 400 kt					
	F=0.15	50 kt	100 kt	200 kt	300 kt	400 kt	F=0.15	50 kt	100 kt	200 kt	300 kt	400 kt
	SSB (thousand tonnes)											
1998	1174	1159	1151	1161	1140	1158	1172	1187	1161	1160	1193	1171
1999	1028	1054	1029	1003	945	923	976	1028	985	948	943	882
2000	937	1054	991	888	753	651	896	1027	947	834	751	611
2001	853	1060	959	780	574	396	822	1033	917	729	570	359
2002	798	1092	953	700	425	188	777	1067	915	653	421	170
2003	783	1175	993	654	304	78	772	1152	957	610	301	74
	Catch (thousand tonnes)											
1998	271	270	270	270	270	270	400	400	400	400	400	400
1999	167	50	100	200	300	400	154	50	100	200	300	400
2000	169	50	100	200	300	400	158	50	100	200	300	400
2001	164	50	100	200	300	400	155	50	100	200	300	400
2002	162	50	100	200	300	368	155	50	100	200	300	333
2003	160	50	100	200	300	229	154	50	100	200	300	221

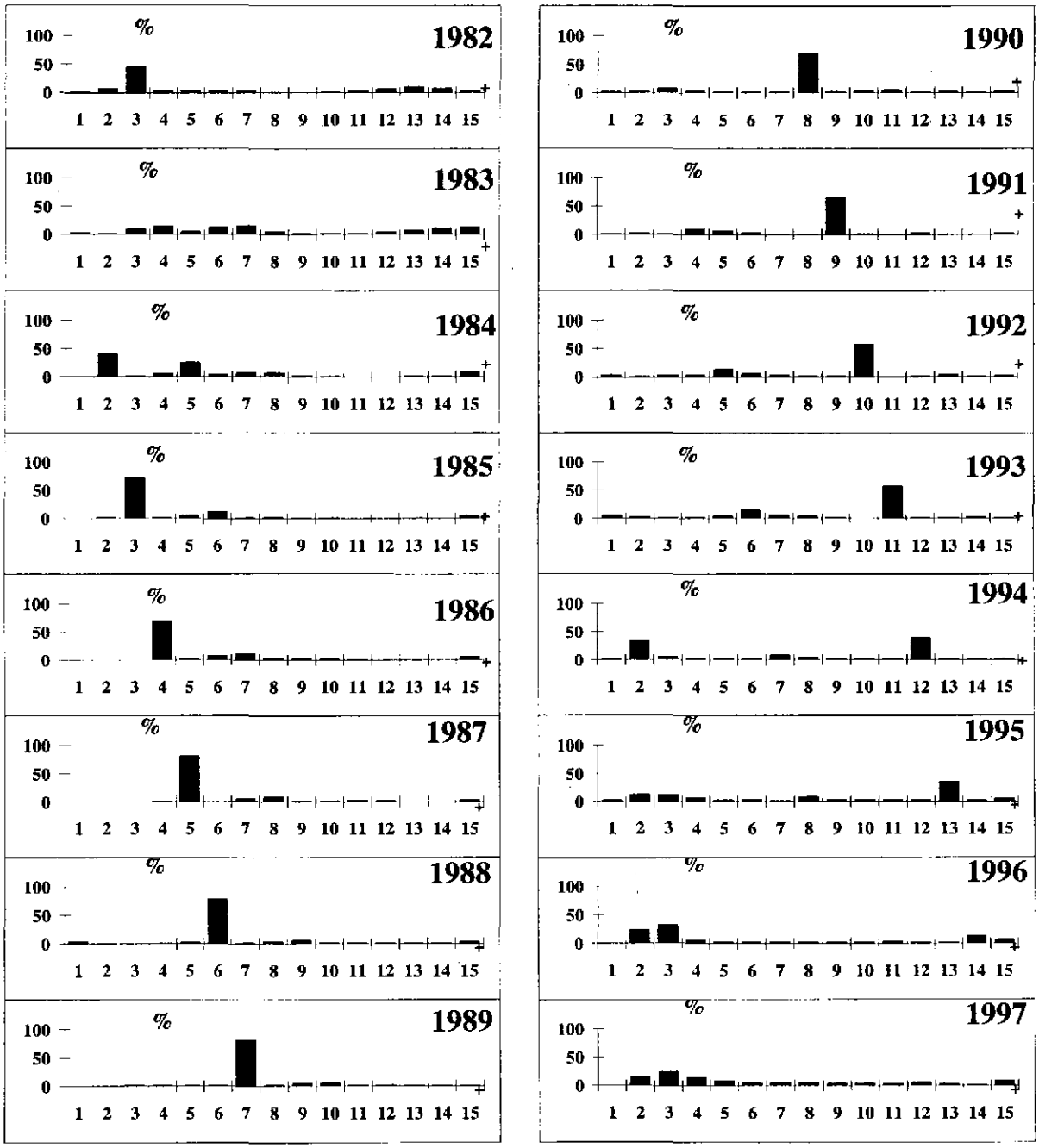


Figure 6.4.1.1 The age composition of the WESTERN HORSE MACKEREL in the international catches from 1982-1997.

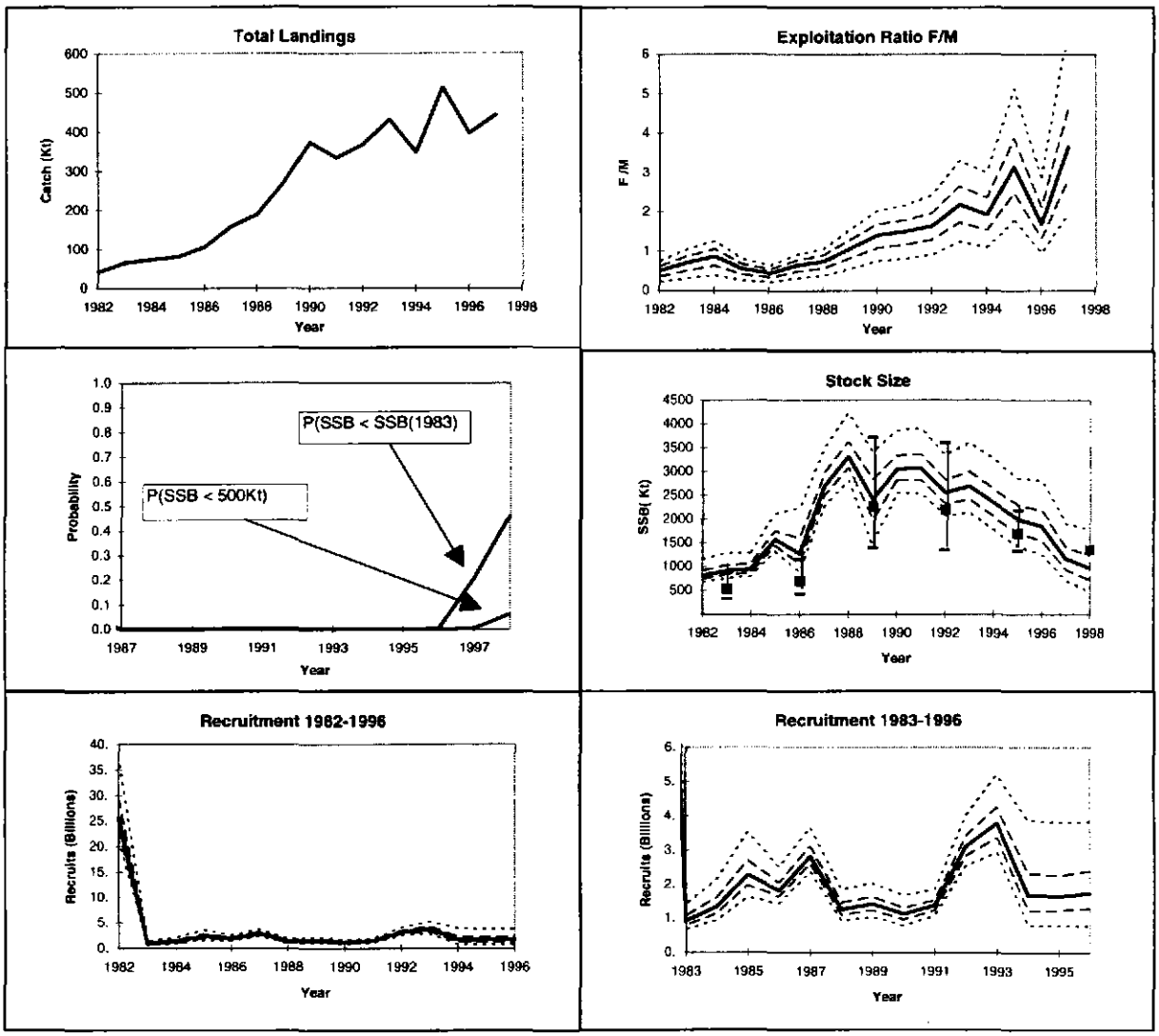


Figure 6.5.3.1 Western Horse Mackerel. Estimated historic stock trajectories for some population dynamics parameters. Fishing mortality calculated as population-weighted mean over ages 5 to 14 and referenced to natural mortality.Square markers indicate egg survey biomass estimates, +/- 95% confidence intervals based on 25% CV. Bold lines, medians. Dashed lines, 25th and 25th percentiles. Dotted lines, 5th and 95th percentiles.

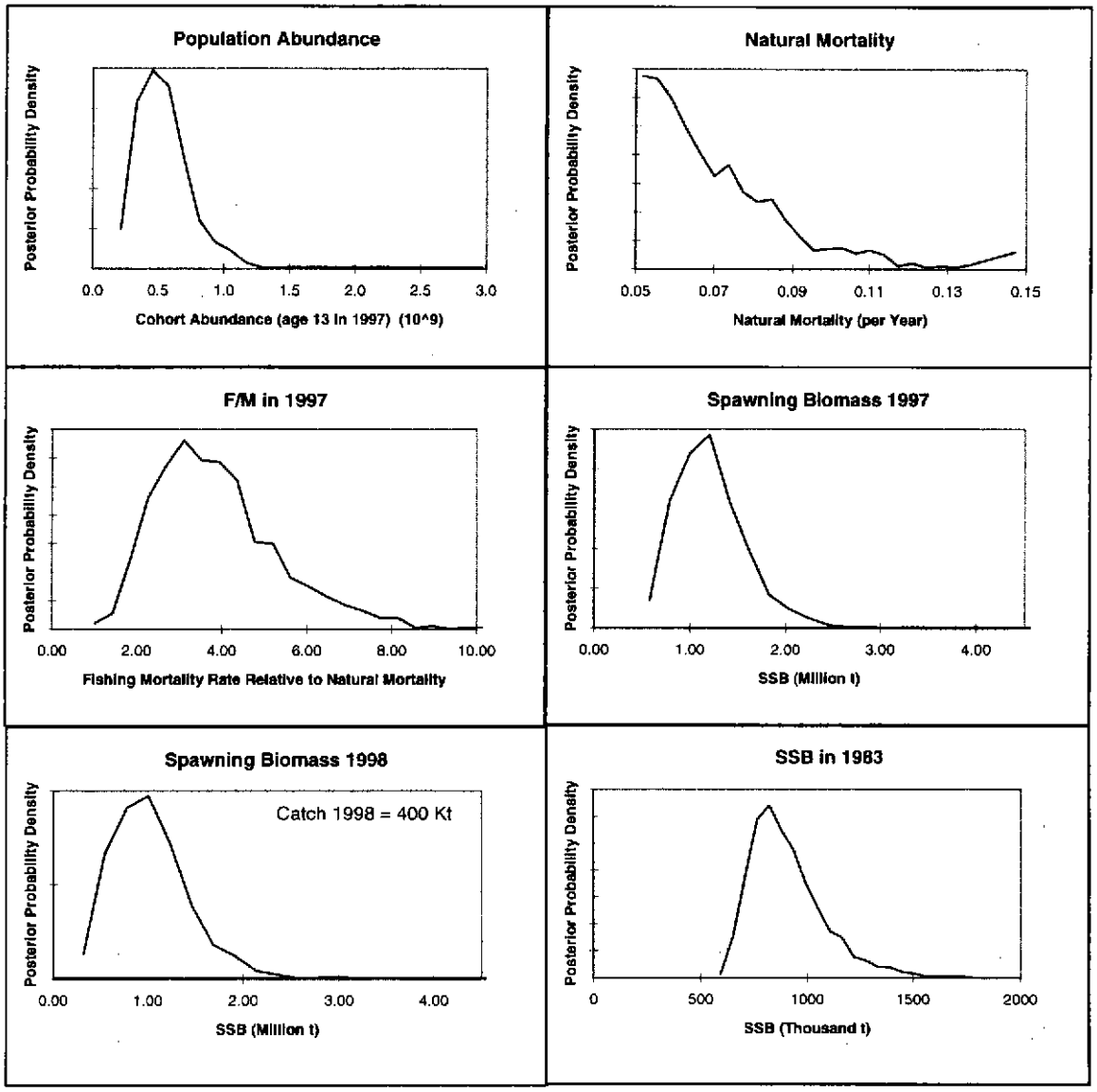


Figure 6.5.4.1. Western Horse Mackerel.Estimates of posterior probability density for some key parameters in the stock assessment.'F' here is taken as the population-weighted arithmetic mean F from ages 4 to 14, and is referenced to M because M is a stochastic variable. Distributions calculated from 4000 samples from Markov Chain thinned at intervals of 100 iterations.

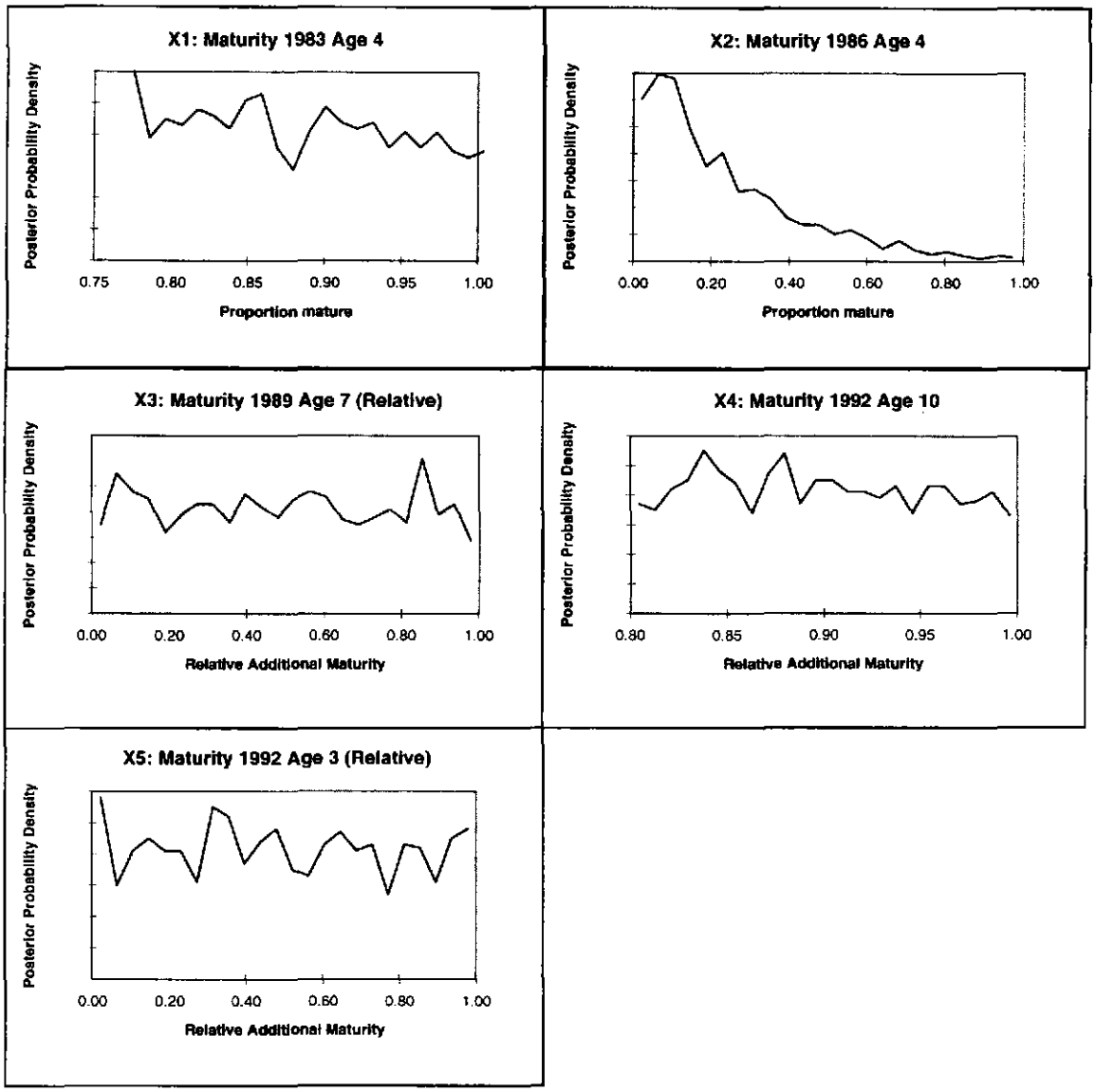
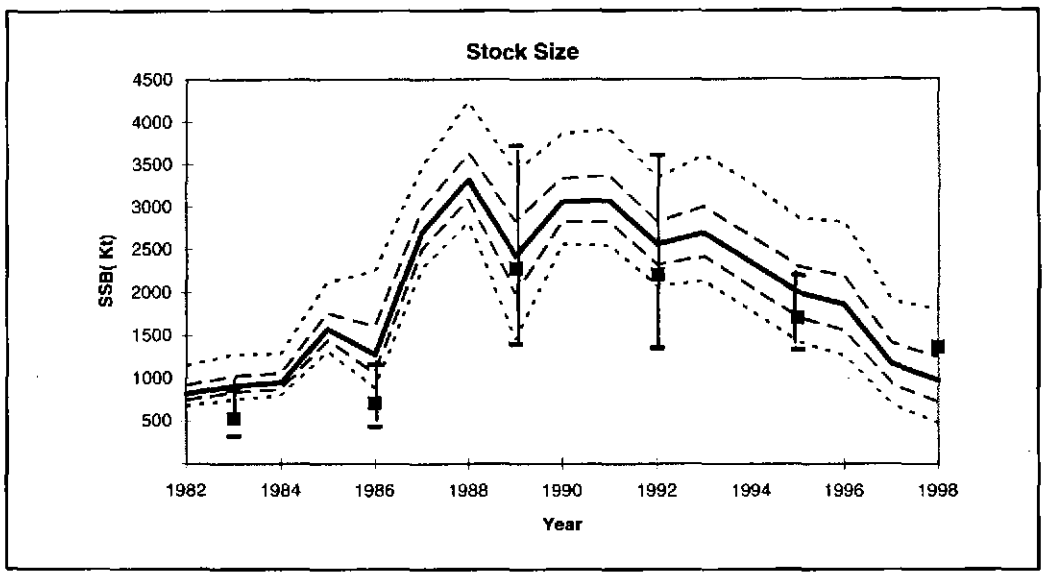


Figure 6.5.4.2 Western Horse Mackerel.Estimates of posterior probability density for some parameters of maturity proportions in the stock assessment.See section 6.7.2.2. for description of the expression of maturity in terms of parameters X1-X5



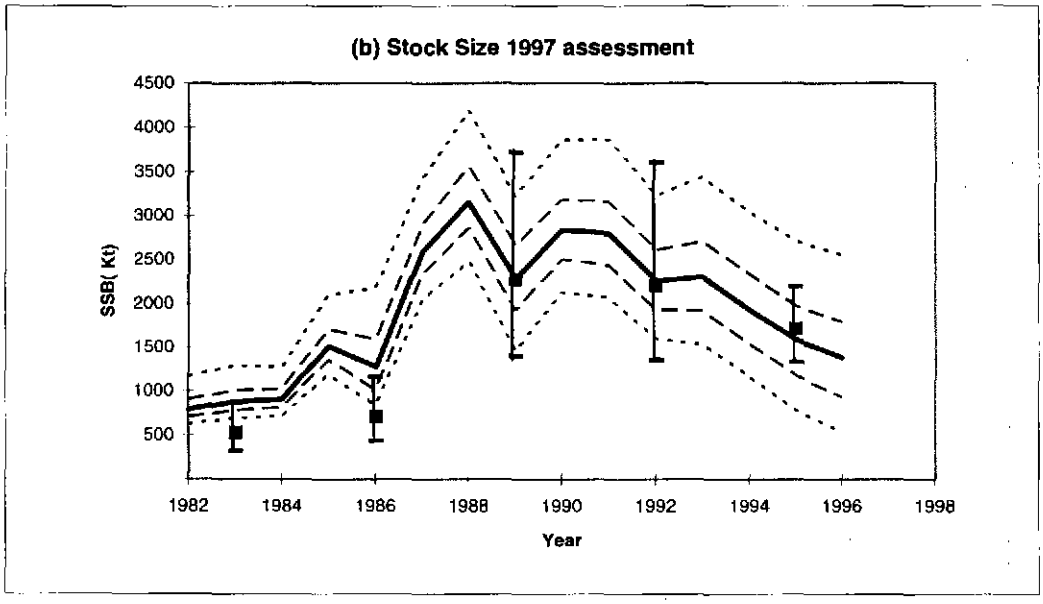


Figure 6.5.4.3 Acomparison between the Baysian assessments carried out in 1997 and 1998

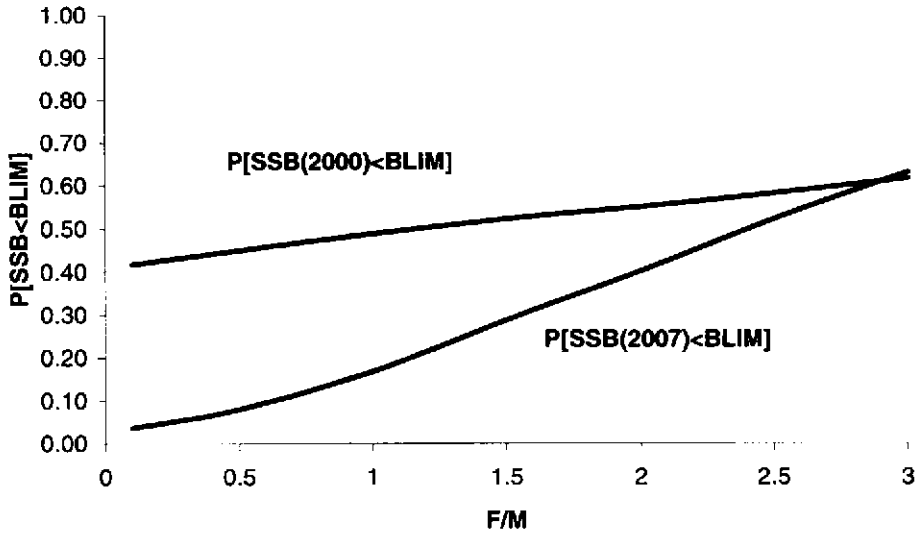


Figure 6.7.1 **The probability of the stock being under 500,000 t at spawning time in 2000 and 2007 for increasing levels of constant exploitation expressed as F/M**

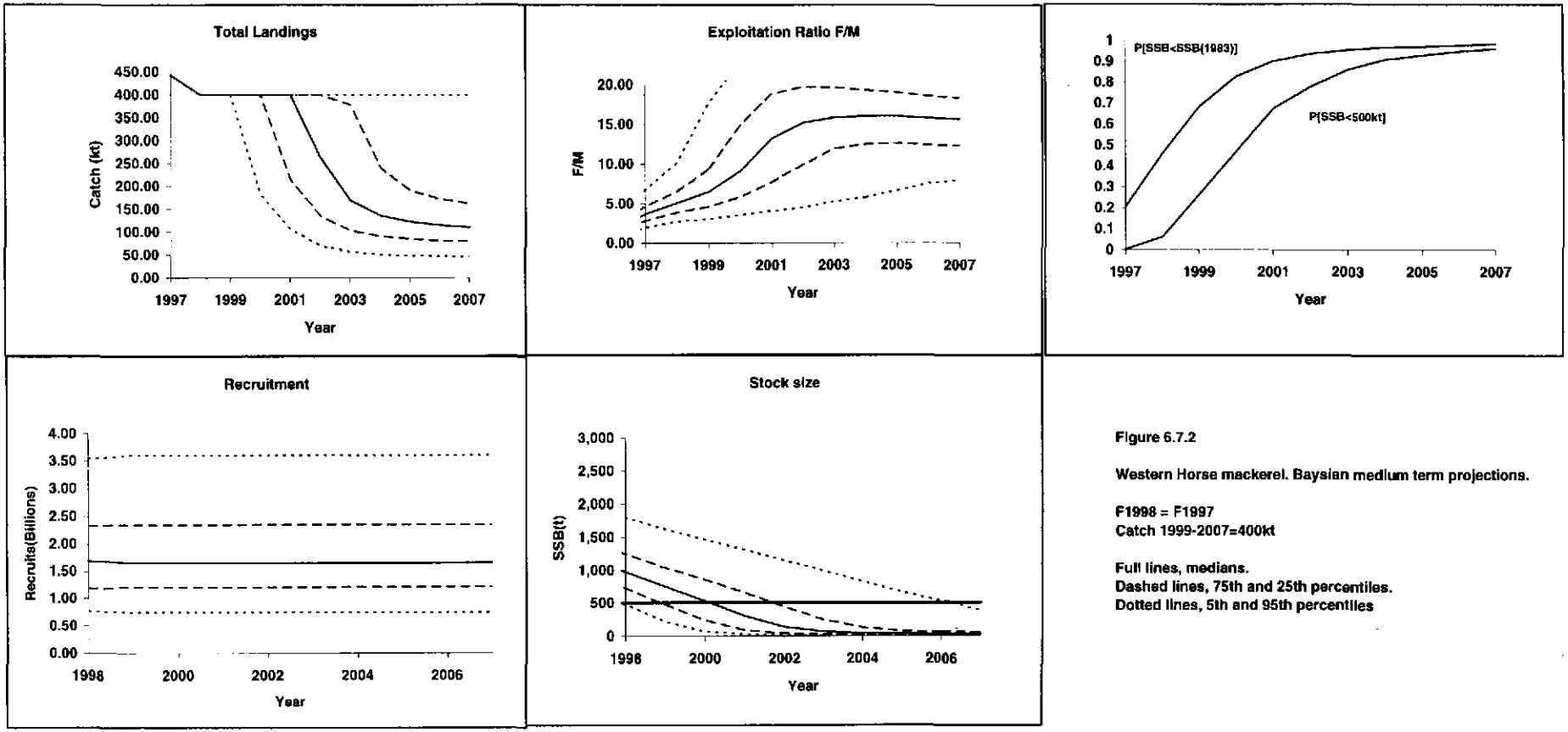


Figure 6.7.2

Western Horse mackerel. Baysian medium term projections.

F1998 = F1997
Catch 1999-2007=400kt

Full lines, medians.
Dashed lines, 75th and 25th percentiles.
Dotted lines, 5th and 95th percentiles

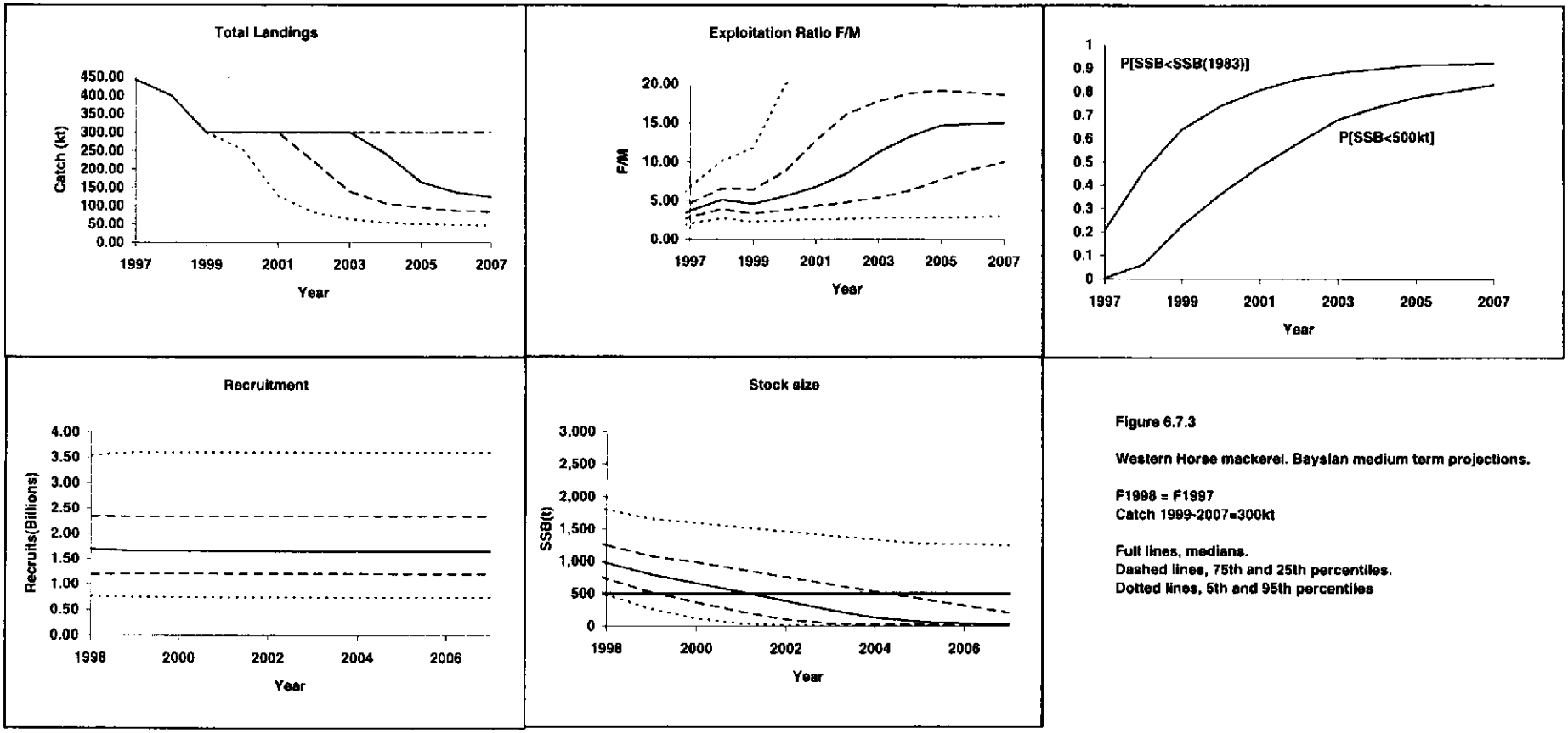


Figure 6.7.3

Western Horse mackerel. Bayslan medium term projections.

F1998 = F1997
Catch 1999-2007=300kt

Full lines, medians.
Dashed lines, 75th and 25th percentiles.
Dotted lines, 5th and 95th percentiles

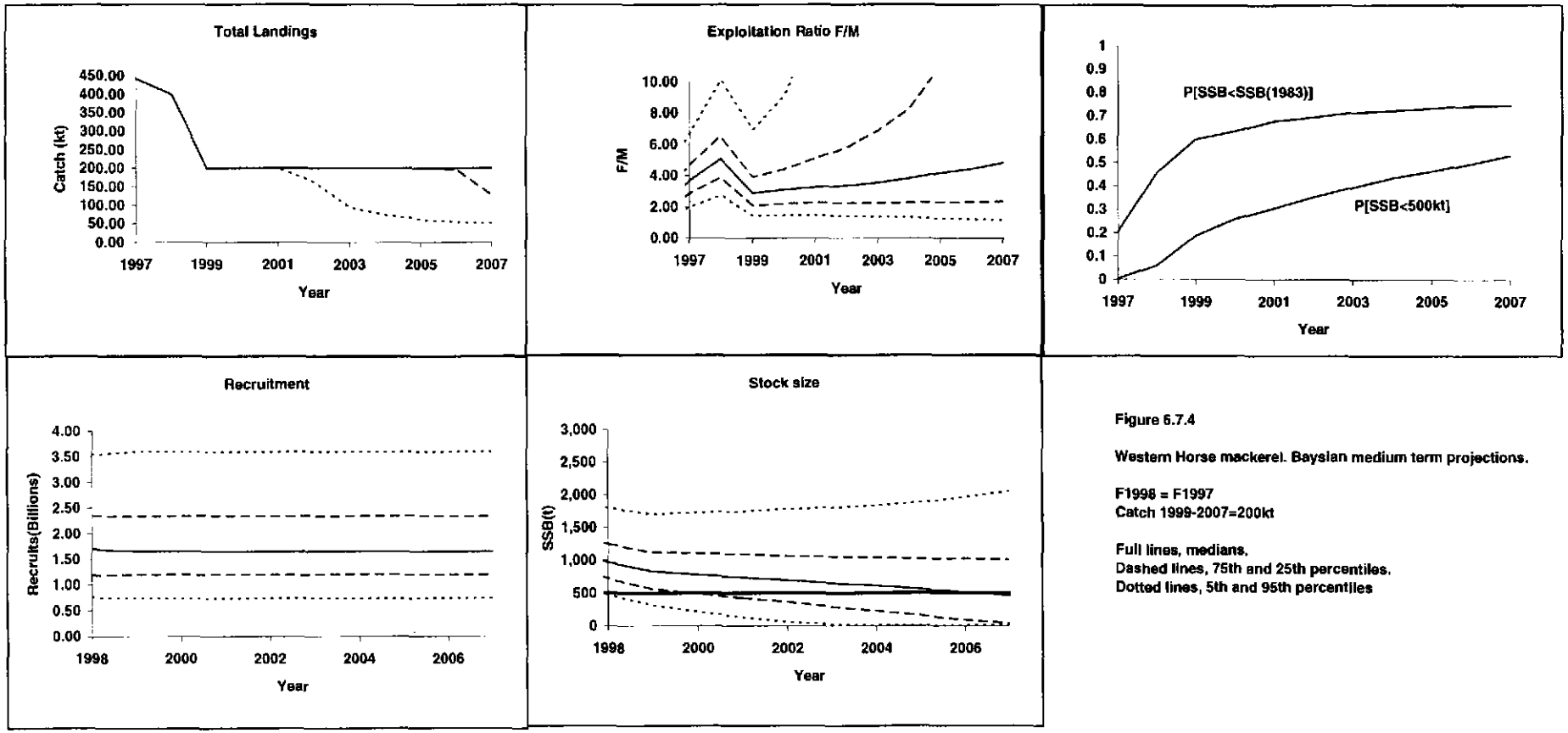


Figure 6.7.4

Western Horse mackerel. Bayslan medium term projections.

F1998 = F1997
Catch 1999-2007=200kt

Full lines, medians.
Dashed lines, 75th and 25th percentiles.
Dotted lines, 5th and 95th percentiles

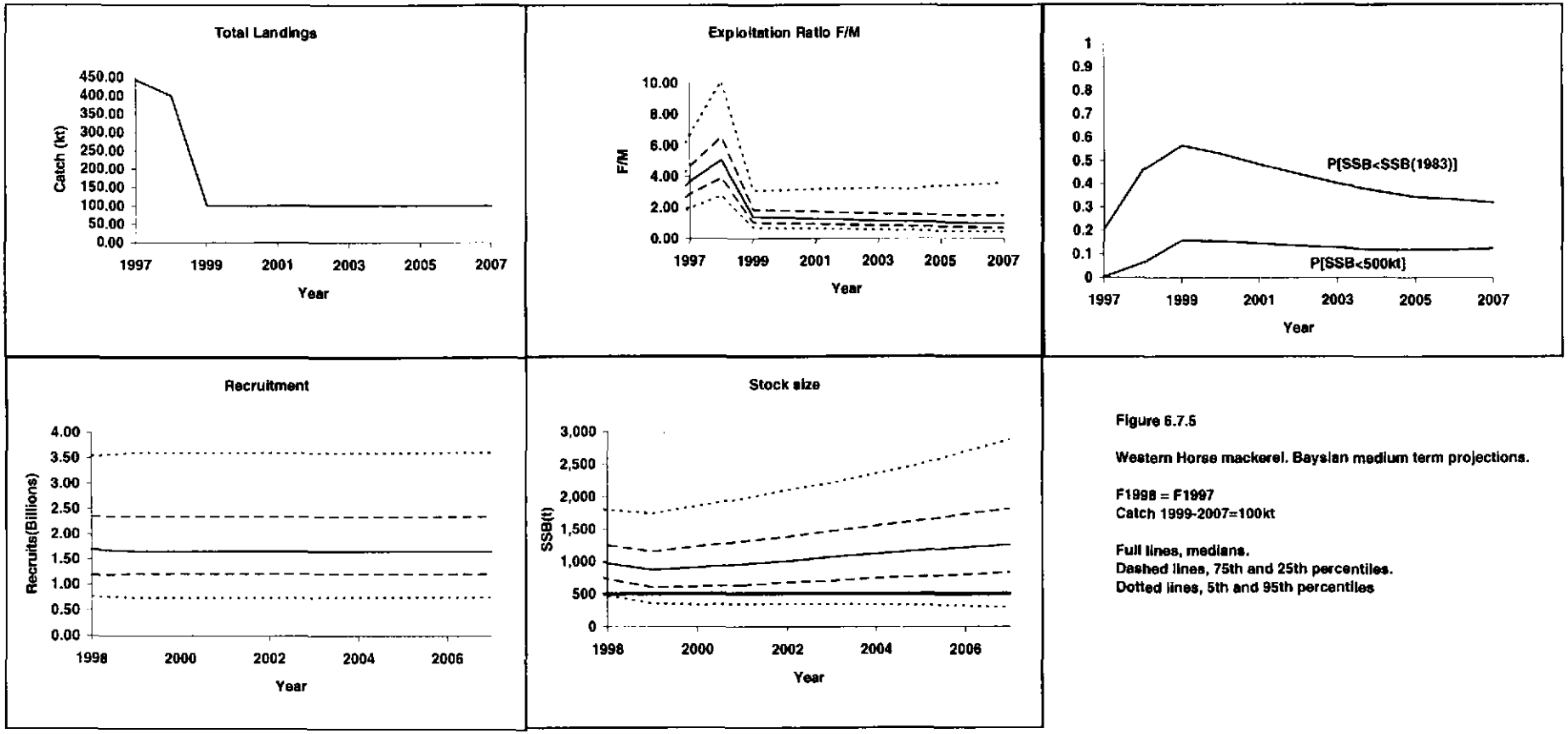


Figure 6.7.5

Western Horse mackerel. Bayslan medium term projections.

F1998 = F1997
Catch 1999-2007=100kt

Full lines, medians.
Dashed lines, 75th and 25th percentiles.
Dotted lines, 5th and 95th percentiles

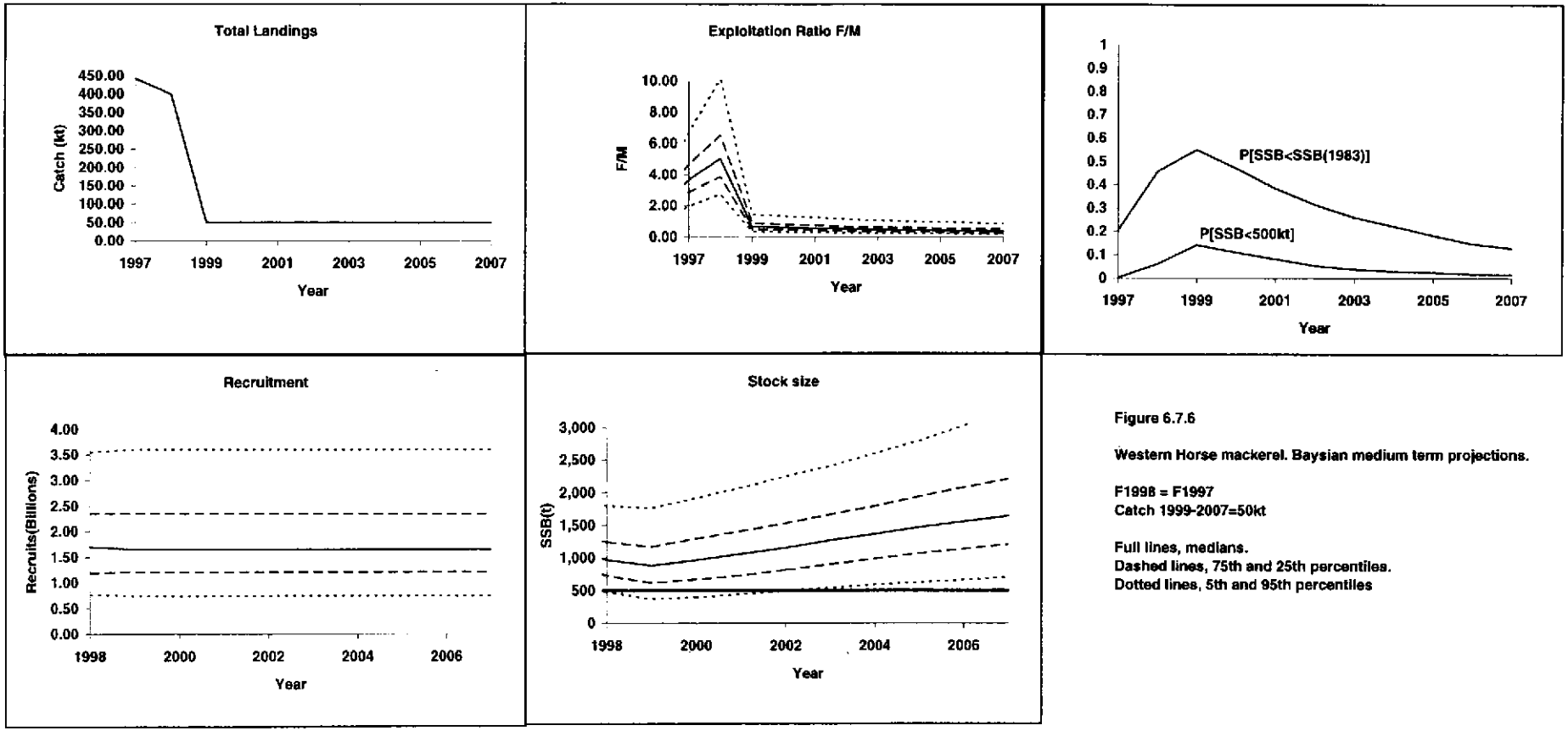


Figure 6.7.6

Western Horse mackerel. Baysian medium term projections.

F1998 = F1997
Catch 1999-2007=50kt

Full lines, medians.
Dashed lines, 75th and 25th percentiles.
Dotted lines, 5th and 95th percentiles

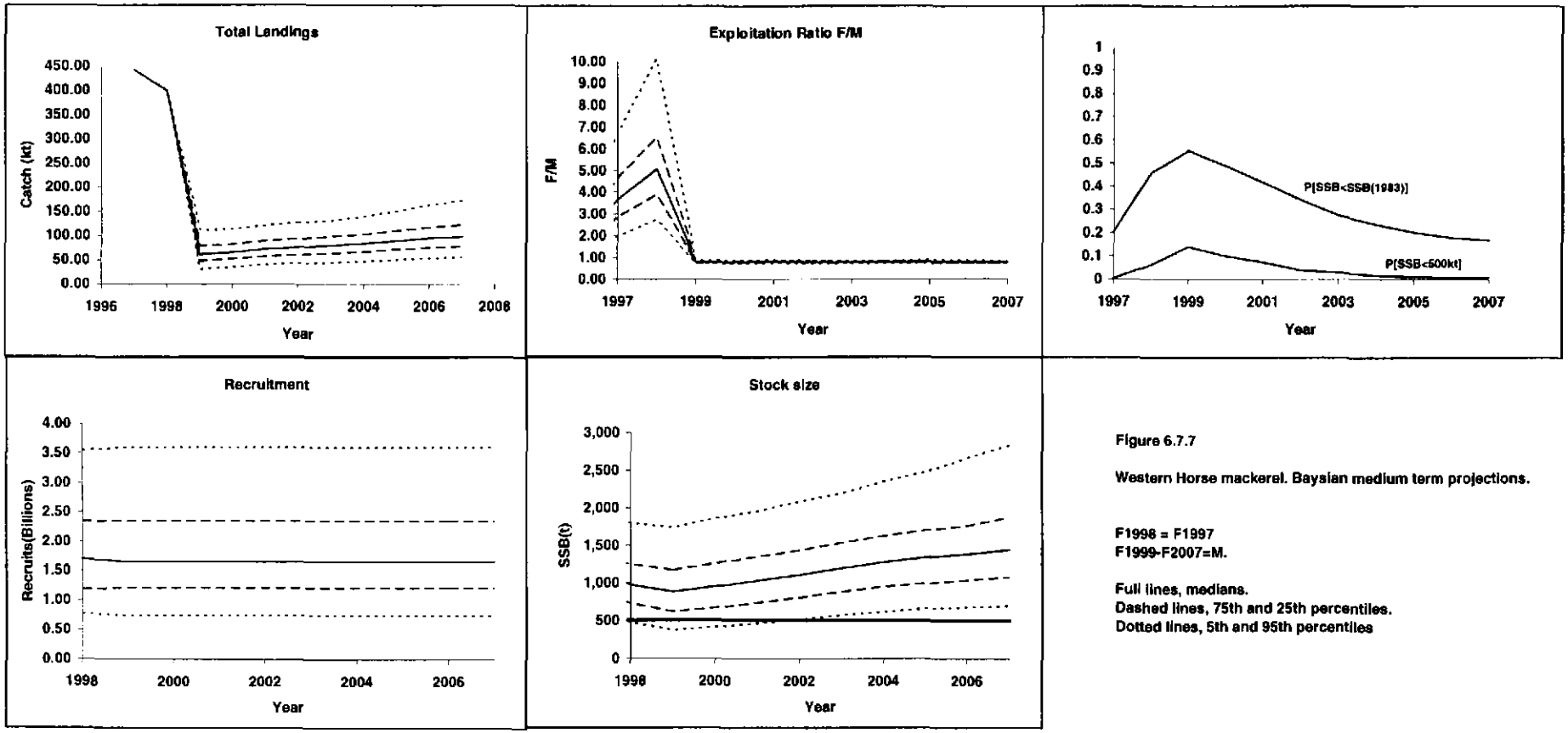


Figure 6.7.7

Western Horse mackerel. Baysian medium term projections.

F1998 = F1997
F1999-F2007=M.

Full lines, medians.
Dashed lines, 75th and 25th percentiles.
Dotted lines, 5th and 95th percentiles

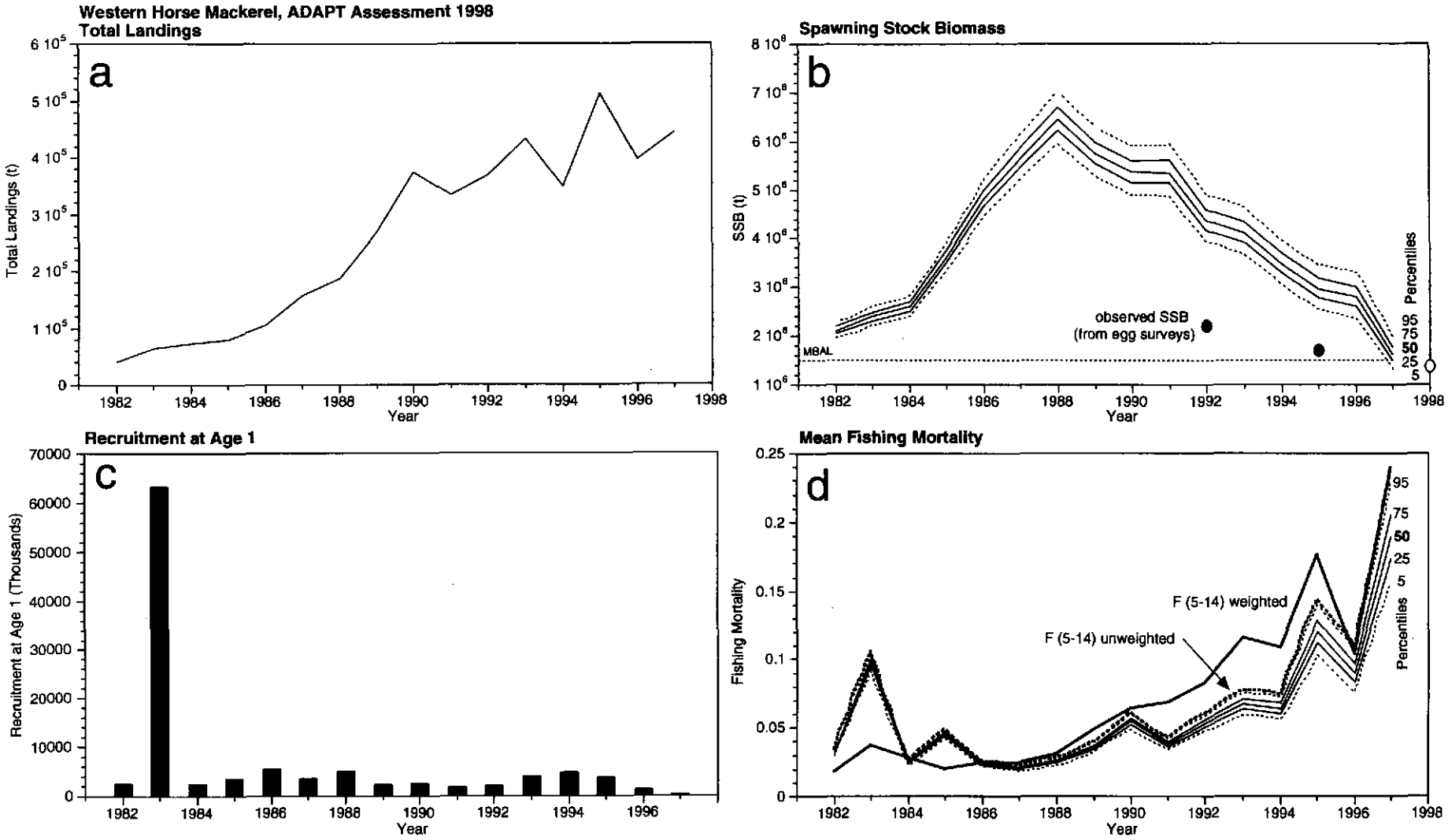


Figure 6.8.1.1 Western Horse Mackerel: Results of the ADAPT-assessment. **a.:** Total landings; **b.:** Spawning stock biomass (median, 5th, 25th, 75th and 95th percentiles of the expected SSB fitted to SSB estimates from egg surveys) compared to SSB values estimated from egg surveys (as circles; note that the 1998 value is preliminary as there is no final evaluation of this survey available) and the Minimum Biological Acceptable Level (MBAL); **c.:** Recruitment at age 1; **d.:** Mean fishing mortality (median, 5th, 25th, 75th and 95th percentiles) and means for age groups 5-14 (unweighted and weighted by stock numbers).

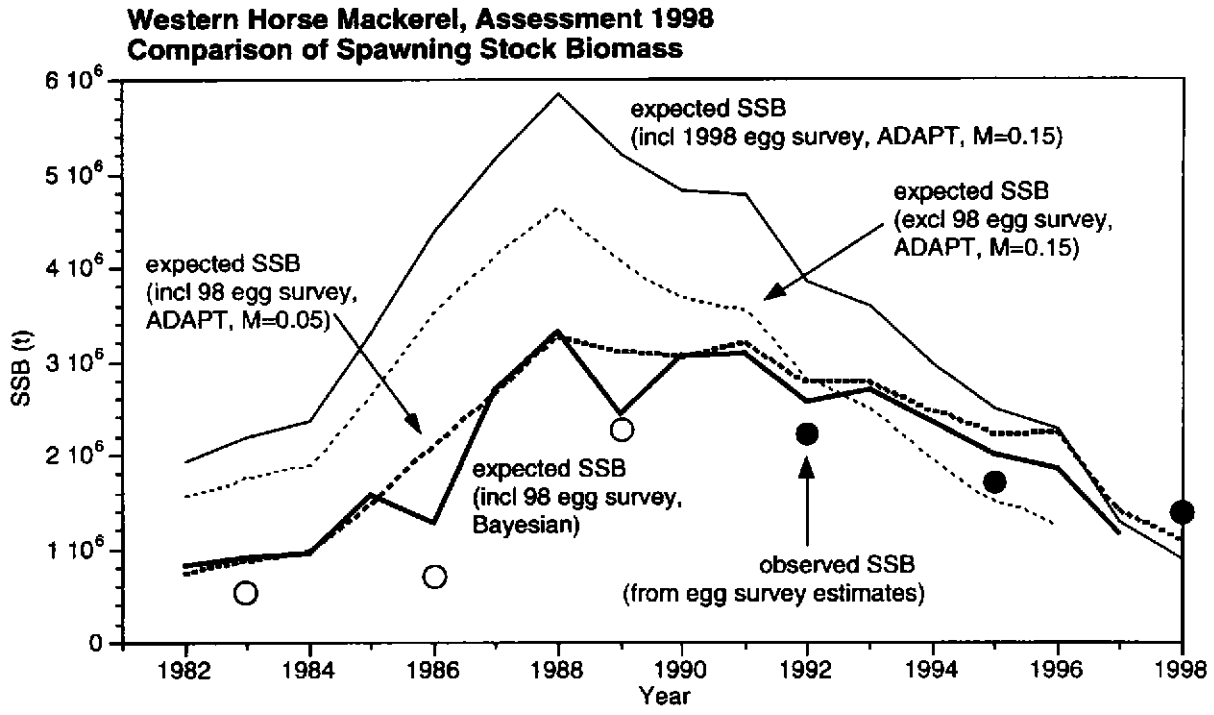


Figure 6.8.1.2 Western Horse Mackerel: Comparison of spawning stock biomass calculated with different assessments (ADAPT vs. Bayesian) and assumptions (excluding or including the 1998 egg survey estimates and using fishing mortalities of either 0.15 or 0.05). Circles give SSB values observed at egg surveys, filled ones were used for the ADAPT assessment, open ones were excluded.

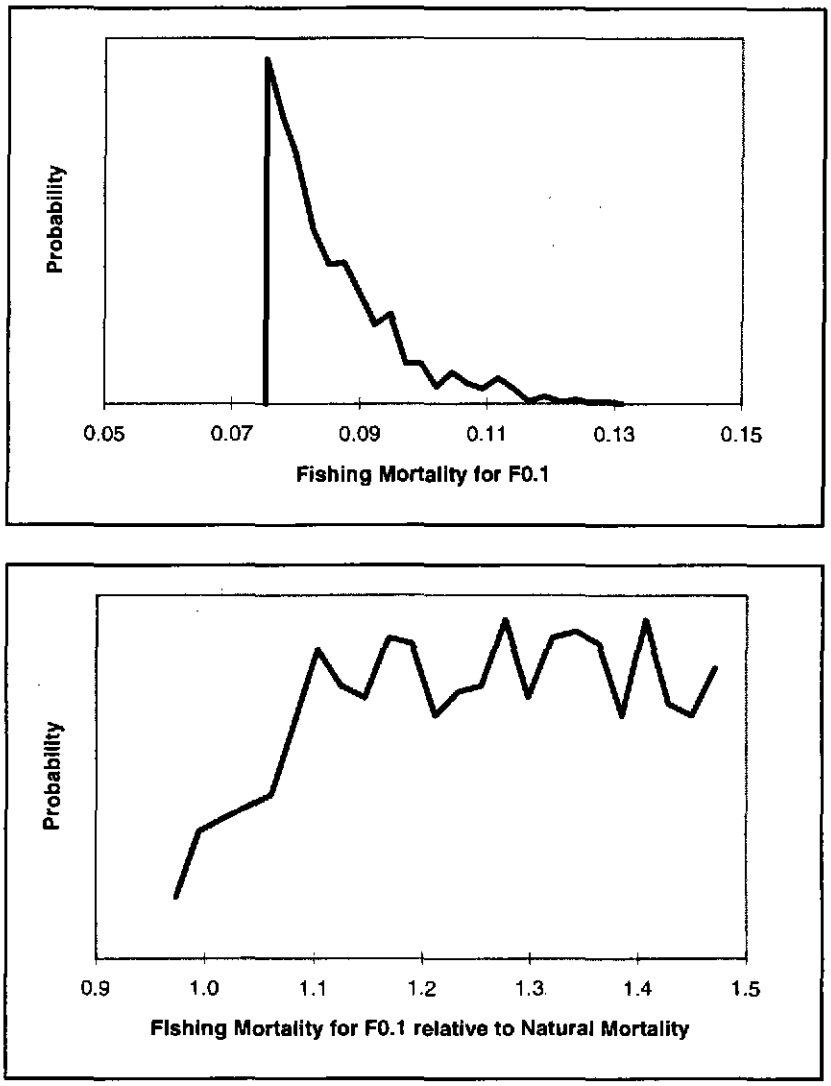


Figure 6.11.2.1 Western Horse Mackerel. Estimated posterior probability distribution for F0.1 (upper panel) and for F0.1/M (lower panel).

7 SOUTHERN HORSE MACKEREL (DIVISIONS VIIIc AND IXa)

7.1 ACFM advice Applicable to 1997 and 1998

ACFM stated that no management objectives have been articulated. In accordance with the precautionary approach, management objectives should be defined. Biological reference points consistent with these objectives need to be identified and implemented as a basis for advice. Fishing mortality should not be allowed to increase above its recent average (1994–1996) of 0.17, which is close to F_{med}, corresponding in 1997 to a catch of 53,000 t and in 1998, 59,000 t. No advice was given for 1997 and the agreed TAC for Divisions VIIIc and IXa is of 56,000 t. ICES recommends that the TAC for this stock should only apply to *Trachurus trachurus* and that other species of horse mackerel be excluded. The present TAC includes catches of other species of horse mackerel.

7.2 The Fishery in 1997

Total catches from Divisions VIIIc and IXa were estimated by the Working Group to be 56,770 t in 1997 which represents an increase of 27% compared with the 1996 catches. The catch by country and gear is shown in Table 7.2.1. The Portuguese catches show an increase of 19% whereas in the Spanish catches the increase is 31% compared with the 1996 catches, which represents the highest figure in the last ten years. In 1997 the increase is due to the higher catches obtained by the Spanish purse seiners and to a lesser extent by the Portuguese trawlers and purse seiners. The large rise in the Spanish purse seiners catches can be explained by the falls in abundance in target species, like sardine and anchovy, which has forced to target others like the horse mackerel (Villamor *et al.*, WD 1998). The proportion of the catches by gear presents a similar pattern than in 1996, being the purse seiner catches the most important ones in the Spanish area (79% of the catches) whereas in the Portuguese waters, the trawler's catches are the majority, representing the 56% of the Portuguese total catch. In 1997 the artisanal Portuguese catches decreased to half of the 1996 catches being the lowest level of the data series.

In this area the catches of horse mackerel are relatively uniform over the year (Borges *et al.*, 1995; Villamor *et al.*, 1996), although the second and third quarters show relatively higher catches than the first and fourth. This is more evident in 1997, possibly due to the predominance of purse seiners catches and the increased effort of this fleet during the spring and summer (see Table 7.2.2).

ICES officially reported catches are requested for "horse mackerel" whose designation includes all the species of the genus *Trachurus* in the area, not only *Trachurus trachurus* L. which is the species at present under assessment by this Working Group. The reported catch therefore always has to be revised by the Working Group in order to eliminate species of horse mackerel other than *Trachurus trachurus* (see Section 1.5).

7.3 Biological Data

7.3.1 Catch in numbers at age

The catch in numbers at age from all gears for 1997 are presented by quarter and area, disaggregated by Sub-division: VIIIc East, VIIIc West, IXa North, IXa Central North, IXa Central South and IXa South (Table 7.3.1.1). Table 7.3.1.2 and Figure 7.3.1.1 present the catch in numbers by year. The 1982 year class is well represented in the catch in numbers at age matrix. The 1986 and 1987 year classes are strong but do not reach the extreme high level of the 1982 year class. The 1991 and 1992 year classes are shown as strong in the catches as 2, 3 and 4 age-groups diminishing in abundance at age 5. The abundance in the catches of the 1996 year class at age 1 is also noticeable.

The sampling covers 100% of the total catch. The number of fish aged seems also to be appropriate, with a total of 3,696 fish aged distributed by quarters. Catch in numbers at age have been obtained by applying a quarterly ALK to each of the catch length distribution estimated from the samples of each Sub-division. The sampling intensity is discussed in Section 1.4. The data before 1985 have not yet been revised according to the approved ageing methodology. So, they have been considered inappropriate for a VPA and have not been included in the analytical assessment.

7.3.2 Mean length and mean weight at age

Tables 7.3.2.1 and 7.3.2.2 show the 1997 mean lengths and mean weights at age in the catch by quarter and Sub-division for the Spanish and Portuguese data. Table 7.3.2.3 presents the weight at age in the stock and in the catch. The matrix of mean weights at age in the stock was calculated in the following way: for each age, the mean weight in the catch in the fourth quarter of each year, was averaged with the mean weight in the catch in the first quarter of the following year. Then an average of averages was calculated for the final mean weight estimate.

The data before 1985 have not yet been revised according to the approved ageing methodology and should therefore be considered only correct for ages 0 and 1, ages in which both methods were in agreement.

7.3.3 Maturity at age

The proportions of fish mature at each age have been considered to be constant over the assessment period. The maturity ogive used previous to the 1992 assessment (ICES 1993/Assess:7) presented low estimations at the age range 5 to 8 due to less availability of this range of fish on the catches (ICES 1993/Assess:7; ICES 1998/Assess:6). As ACFM requested in 1992 the maturity ogive was smoothed as follows. The Working Group proposes that recent information of maturity at age be analysed and presented next meeting.

Age Group												
0	1	2	3	4	5	6	7	8	9	10	11	12
0.00	0.00	0.04	0.27	0.63	0.81	0.90	0.95	0.97	0.98	0.99	1.0	1.0

7.3.4 Natural mortality

According to the ageing methodology established in the ICES area (Eltink and Kuiper, 1989; ICES 1991/H:59) the life span for the southern horse mackerel was considered to be longer. Therefore the natural mortality was revised (ICES 1992/Assess:17), changing the previous level from 0.20 to the present 0.15. The analytical assessments performed since 1992 have not shown any inconsistency due to this level of natural mortality.

7.4 Fishery Independent Information and CPUE Indices of Stock Size

7.4.1 Trawl surveys

There are three survey series: The Portuguese July survey, the Portuguese October survey and the Spanish October survey. The two October surveys covered Sub-divisions VIIIc East, VIIIc West, IXa North (Spain) from 20–500 m depth and, Sub-divisions IXa Central North, Central South and South, in Portugal, from 20–750 m depth. The same sampling methodology was used in both surveys but there were differences in the gear design, as described in ICES (1991/G:13). The Portuguese October and July survey indices and the Spanish September/October survey indices are estimated by strata for the range of distribution of horse mackerel in the area, which has been consistently sampled over the years. This corresponds to the 20–500 m strata boundaries. It was demonstrated that the horse mackerel off the Portuguese shelf are stratified by length according to the depth and spawning time (ICES 1993/Assess:19). This explains the special characteristics of the composition of the catches, the lower availability of fish after first maturing which creates a peculiar selection pattern.

Table 7.4.1.1 indicates the catch rates from research vessel surveys in Kg per tow, for comparison with the total biomass trend. The biomass index from the Portuguese October survey was shown to be 156% higher than observed in 1996 only surpassed in the time series by the extremely high value of 1993 biomass index. The series of the Portuguese July survey has a less variability in the data than that of the Portuguese October survey. In 1997 the index is at the mean level of the data series. There was not Portuguese July survey in 1996. The Spanish October survey biomass index indicates a decrease of 46% compared with the 1996 index. This represents a break in the upward biomass trend that can be observed since 1992.

Table 7.4.1.2 shows the number at age from the Spanish and Portuguese bottom trawl in the October surveys and from the Portuguese July survey. The Spanish September/October survey series is available from 1985 to 1997 and the Portuguese October survey from 1981–1997. Both are carried out during fourth quarter when the recruits have entered the area. In the Portuguese October survey the recruitment (age 0) observed in 1997 was the highest in the data series. On the contrary, in the Spanish area, the index at age 0 from the October survey is the lowest value reached in the series, continuing the low levels obtained since 1995. It seems that there exists no good agreement between these surveys in the abundance index for 0 group. In the Spanish October survey in 1997 the strong 1986 and 1987 year classes were still abundant, a decrease in the yields on the range of ages from 0 to seven years old was evident, changing the pattern observed in 1996 (Table 7.4.1.2). In the Portuguese July survey there is a strong fall in the 1995 and 1997 abundance indices observed in all the ages (except for younger ages in 1997) compared with those obtained in 1994 despite using the same vessel, sampling and gear methodology. The 1982 year class is conspicuous in all the survey series but is stronger in the October Spanish bottom trawl survey.

7.4.2 Egg surveys

This was the first series of surveys carried out in the southern area for the Annual Egg Production Method (ICES 1996/H:2). The estimate of 1995 SSB for the southern horse mackerel from those surveys was 261,000 t. Data from horse mackerel egg surveys carried out in Spanish and Portuguese waters during 1998 are at present not available. It will be presented to the 1999 Mackerel and Horse Mackerel Egg Surveys Working Group.

7.5 Effort and Catch per Unit Effort

Figure 7.5.1 shows the evolution of the commercial effort series from the Spanish trawl fleets fishing in Sub-division VIIIc West (La Coruña) and in Sub-division VIIIc East (Avilés) from 1984 to 1997. The effort is at the similar low level reached in 1996 although in the Avilés trawl fleet a slight increase of 12% occurs.

Table 7.5.1 presents the commercial catch rates from the trawl fleet fishing in Sub-divisions IXa Central North, IXa Central South and South (Portugal) from 1979 to 1990 and trawl fleets from Spain fishing in Sub-division VIIIc West (La Coruña) and in Sub-division VIIIc East (Avilés) from 1983 to 1997. A significant decrease in the catch rates of the Spanish trawl fleets, compared with the 1996 levels, occurs, being of 38.5% and of 25% for Avilés and La Coruña trawl fleets respectively. The level reached by the trawl fleet operating in Sub-division VIIIc West (La Coruña) is the lowest since 1984. Horse mackerel trawl catch rates from the Portuguese trawl fleet fishing in Division IXa are not available since 1991, because the effort data series is under revision.

Catch per unit effort at age

CPUE at age from the Galician (La Coruña) bottom trawl fleet (Sub-division VIIIc West) and from the Cantabrian (Avilés) trawl fleet fishing in Sub-division VIIIc East are available from 1984 to 1997.

In the Galician trawl fleet a decrease in the catch rates of the ages in the range between "0" group to six years old was observed in 1997. The younger ages are also poorly represented in the Aviles trawl fleet in 1997. The extremely strong 1982 year class is still very prominent in the data for both fleets at age plus group 15 (Table 7.5.2). In 1997, the 1986 and 1987 year classes were confirmed as being strong ones, giving high indices of abundance in both fleets.

7.6 Recruitment Forecasting

In 1997 the indices of the 0 group from the surveys carried out in the recruitment season (the Spanish and Portuguese October surveys) are divergent. Again in 1996 the values from the Portuguese October survey were higher (Table 7.4.1.2.). In 1994, the Spanish October survey indicated high recruitment at age 0 and the Portuguese October Survey estimated low recruitment for the 1994 year class. In 1995 both surveys indicated a low level of 0 group abundance which is in agreement with the VPA estimate.

7.7 State of the Stock

7.7.1 Data exploration and preliminary modelling

All available data were used in the preliminary assessment of this stock. Given the high coherence of the time series and of the previous assessments carried out using Extended Survivors Analysis (XSA), no alternative methods were considered to be used with this stock.

Fishing mortality coefficients were estimated using XSA. In accordance with last year's assessment, the XSA parameters were set at catchability independent of age for ages equal or greater than 9 years old, and the plus group at 12.

The strength of shrinkage has a significant effect on the standard errors of the log catchability (Anon. 1995/Assess:2). Stronger shrinkage (lower CVs) increases the standard errors for all fleets. In order to compare the independent information provided by the different fleets, XSA was run separately for each of the fleets, without shrinkage.

The external information used in the tuning was:

Fleet 1: *Catch per unit of effort of the trawl fleet from* ***La Coruña (VIIIc West - North Galicia)***
Fleet 2: *Catch per unit of effort of the trawl fleet from* ***Avilés (VIIIc East - Cantabrian Sea)***
Fleet 3: *Portuguese* ***October Trawl Survey*** *during the Recruitment season* ***(Division IXa)***
Fleet 4: *Portuguese* ***July Trawl Survey*** *end of spawning season in* ***Division IXa***
Fleet 5: *Spanish October trawl Survey during the recruitment season* ***(Sub-division IXa North and Division VIIIc)***

The slopes of the linear regressions between log-catchability and log-population were analysed: Fleet 1, presented a negative slope at age 0, with a low coefficient of determination, as did Fleet 2, at age 1 with a slightly higher coefficient of determination. These data were plotted and it was decided to not include those ages in the tuning, because they were not providing any information. For Fleet 2 it was considered also appropriate to eliminate the age range 0–4 because these ages presented very high standard errors. The same procedure was used for Fleet 5, age range 0–4, which did not perform well for young fish. Some ages in Fleets 3 and 4 also presented negative slopes, however, these were not statistically different from zero, hence it wasn't necessary to exclude these ages.

Figure 7.7.1.1 compares the SSB estimated for 1995, 1996 and 1997 by source of independent information. For the year 1995 it is also possible to compare the estimations provided by the fleets with the 1995 egg survey SSB. Low SSB values were estimated from the July surveys and the highest values of SSB correspond to the estimations provided by the Fleet 2 operating in the Cantabrian Sea during all the year. The adults are more abundant in the area during the spawning season when the spawning aggregations occur. The 1995 egg survey estimation indicates a value close to the 1995 SSB estimated by all the fleets and by the October Portuguese survey. The assessment performed and accepted last year indicates a 1995 SSB close to the 1995 egg survey SSB.

Thus the options for the present assessment were taken in accordance with the exploratory analysis, and keeping consistency with last year's assessment.

7.7.2 Stock assessment

The final stock assessment was performed following the conclusions of the preliminary modelling (Section 7.7.1). Figure 7.7.2.1 presents the comparison of the Fs of the 1996 and 1997 assessments made with XSA, including all the fleets and a shrinkage of 1.00. It may be seen that for the reference F_{bar} (1–11) the estimate shows an extremely close agreement with last year's assessment. Given the pattern of exploitation this stock is subjected to high selection on the younger and older ages and a reduced availability of 4–6 years old fish in the catches. The estimates of F_{bar} (0–3) and F_{bar} (7–11) also show a very close agreement with last year's assessment.

Figure 7.7.2.2 illustrates the retrospective SSB estimates performed by the final VPA, and the 1995 egg survey estimate, indicating a very good agreement among them.

The tuning diagnostics and final results are given in Tables 7.7.2.1–7.7.2.4. Figure 7.7.2.3 shows the fish stock summary trends over the period 1985–1997 according to the final assessment.

7.7.3 Reliability of the assessment and uncertainty estimation

This assessment is very consistent with last year's assessment. The spawning stock biomass estimated from the 1995 egg surveys is in close agreement with the 1995 SSB level estimated using the two October surveys, the July survey information and the two commercial fleets.

7.8 Catch Predictions

The terminal population in 1997 from the final VPA was used as input to the catch forecast for age groups 1 and older. Recruitment at age 0 was assumed to be the geometric mean of the period 1985–1994. The exploitation pattern was taken as the arithmetic mean of the last three years, without scaling to the last year, which is assumed to correspond to the most likely exploitation in the short term. Table 7.8.1 gives the input parameters and Tables 7.8.2.a–c and Figure 7.8.1 show the results of the short-term predictions of the catch and spawning stock biomass.

At $F_{status\ quo}$ (F_{bar} 95–97) the predicted catch in weight for 1998 is 55,771 t. In 1999, assuming the same recruitment level, the catch at $F_{status\ quo}$ is predicted to be 58,479 t. The spawning stock biomass is predicted to decrease from 262,730 t at the beginning of 1998 to 249,221 t in 1999 at $F_{status\ quo}$, and to 249,061 t if the TAC of 56,000 t is taken in 1998. The spawning stock biomass is predicted to decrease in 2000, at $F_{status\ quo}$ to 239,545 t.

7.9 Short-Term Risk Analysis

A sensitivity analysis was performed on our short-term catch predictions using the methodology and software by Cook (1993). The results of this analysis are shown in the plots of Figure 7.9.1. The values plotted in the barplots are proportional to the influence of each parameter on the final value of the variables of interest: the yield in 1999 and the SSB in 2000 (a list of the parameters is given in Table 7.9.1 and their input values are in Table 7.9.2). The pies on the right side of Figure 7.9.1 show the relative percentages of the same values.

The plot at the top of Figure 7.9.2 describes the probability of F(1999) being higher than $F_{status\ quo}$, given several values of yield for 1999. It can be seen that for a catch of approximately 60,000 t in 1999, the F(1999) has a 0.5 probability of becoming higher than $F_{status\ quo}$. The plot at the bottom of Figure 7.9.2 shows the probability of the SSB in 2000 being lower than a given value (in abscissa) assuming $F_{status\ quo}$ for the whole period (1998–2000). At present we have about 0.5 probability of SSB in 2000 being lower than 225,000 t.

The probabilities shown in Figure 7.9.2 were calculated by the method of Cukier *et al.* (1978), in which values for the state variables are repeatedly calculated introducing periodic disturbances in the parameters. Empirical distributions of the state variables are then obtained, from which the variability due to each parameter can be estimated by Fourier analysis.

7.10 Medium-Term Predictions

Medium-term predictions were carried out using the software WGTERMA (ICES 1994/Assess:6). Predictions were made assuming stochastic recruitment and uncertainty in the initial population sizes. 500 simulations were performed. Figure 7.10.1 shows from left to right and top to bottom the stock-recruitment plot, the evolution of the yield, of the recruitment and of the SSB assuming $F_{status\ quo}$ till 2007. The dotted line represents the average and solid lines the 5, 10, 20, 50 and 95 percentiles.

Figures 7.10.2 and 7.10.3 show the predicted values of SSB until 2000 and until 2007 assuming different Fs. F-factor 1.0 corresponds to $F_{status\ quo}$. The value of this reference point is represented in these figures, along with F_{med} and F_{max}. All three reference points present relatively similar values. B_{pa} and B_{loss} are also represented in these figures as solid parallel lines. B_{pa} was defined as 206,000 t (see Section 7.12), corresponding roughly to the minimum observed SSB, if we exclude one extreme observation that is placed far from the cloud of points (see top-left plot in Figure 7.10.1). B_{loss} was defined as 136,000 t, corresponding to the lowest SSB observed considering all points of the SSB-recruitment plot.

7.11 Long-Term Yield

The long-term yield per recruit and spawning biomass-per-recruit curves, against F, derived using the input data in Table 7.8.1 are shown in Figure 7.8.1. Table 7.11.1 presents the yield per recruit summary table. $F_{0.1}$ is estimated to be 0.09, and F_{max} to be 0.17, at the reference age (1–11).

7.12 Reference Points for Management Purpose

The reference points were estimated using the PA software (CEFAS, Lowestoft). The estimated F_{med} value is 0.165 and F_{high} corresponds to 0.26 (see Figure 7.12.1). The present level of $F_{status\ quo}$ of 0.18 is above the F_{med} level and F_{max} which is 0.17.

As can be seen from Figure 7.12.2, the range of SSBs is quite narrow, and no stock-dependent trend in the recruitment can be inferred from these observations. The extremely strong 1982 year class has contributed substantially to the SSB during the whole period 1985–1997. The lowest biomass attained during the period was 130,000 t in 1985, which originated a medium recruitment. F_{loss} is 0.27, well above F_{max} and F_{med}.

Last year this Working Group proposed F_{max} as F_{pa}. This was further supported by the Study Group on the Precautionary Approach to Fisheries Management (ICES 1998/ACFM:10). Our present results do not suggest any changes for this recommendation.

B_{lim} is defined as B_{loss} which corresponds to be 136,300 t, the lowest SSB in the series. B_{pa} is considered as $B_{loss}\, e^{1.645\,\sigma}$ that corresponds to 206,000 t.

7.13 Harvest Control Rules

No harvest control rules were proposed neither by the Study Group on the Precautionary Approach to Fisheries Management (ICES 1998/ACFM:10) nor by this Working Group.

7.14 Management Considerations

The predicted evolution of this stock in terms of SSB, F_{lim}, F_{pa}, B_{lim} and B_{pa} is shown in Figure 7.14.1. Table 7.14.1 summarises several management options at: $F_{status\ quo}$, F constrained to the official TAC of 56,000 t, F corresponding to TAC 1998, F_{med} and F_{max} ($=F_{pa}$).

In 1997, F attained a value considerably higher than F_{pa} ($F_{97} = 0.22$). In order to prevent future increase of the fishing mortality two measures should be put in practice: a reduction of TAC to 52,000 t, which corresponds to F_{pa}, and a reduction of fishing effort. Taking into account that $F_{status\ quo}$ is 0.175 and F_{pa} is 0.165, an increase of the fishing effort should be avoided.

The Working Group also considers that the TAC should not be applied to all *Trachurus* species combined but only to *Trachurus trachurus*.

Table 7.2.1 Annual catches (tonnes) of SOUTHERN HORSE MACKEREL by countries by gear in Divisions VIIIc and IXa. Data from 1984–1996 are Working Group estimates.

Year	Portugal (Division IXa)				Spain (Divisions IXa + VIIIc)					Total VIIIc+IXa
	Trawl	Seine	Artisanal	Total	Trawl	Seine	Hook	Gillnet	Total	
1962	7,231	46,345	3,400	56,976	-	-	-	-	53,202	110,778
1963	6,593	54,267	3,900	64,760	-	-	-	-	53,420	118,180
1964	8,983	55,693	4,100	68,776	-	-	-	-	57,365	126,141
1965	4,033	54,327	4,745	63,105	-	-	-	-	52,282	115,387
1966	5,582	44,725	7,118	57,425	-	-	-	-	47,000	104,425
1967	6,726	52,643	7,279	66,648	-	-	-	-	53,351	119,999
1968	11,427	61,985	7,252	80,664	-	-	-	-	62,326	142,990
1969	19,839	36,373	6,275	62,487	-	-	-	-	85,781	148,268
1970	32,475	29,392	7,079	59,946	-	-	-	-	98,418	158,364
1971	32,309	19,050	6,108	57,467	-	-	-	-	75,349	132,816
1972	45,452	28,515	7,066	81,033	-	-	-	-	82,247	163,280
1973	28,354	10,737	6,406	45,497	-	-	-	-	114,878	160,375
1974	29,916	14,962	3,227	48,105	-	-	-	-	78,105	126,210
1975	26,786	10,149	9,486	46,421	-	-	-	-	85,688	132,109
1976	26,850	16,833	7,805	51,488	89,197	26,291	376[1]	-	115,864	167,352
1977	26,441	16,847	7,790	51,078	74,469	31,431	376[1]	-	106,276	157,354
1978	23,411	4,561	4,071	32,043	80,121	14,945	376[1]	-	95,442	127,485
1979	19,331	2,906	4,680	26,917	48,518	7,428	376[1]	-	56,322	83,239
1980	14,646	4,575	6,003	25,224	36,489	8,948	376[1]	-	45,813	71,037
1981	11,917	5,194	6,642	23,733	28,776	19,330	376[1]	-	48,482	72,235
1982	12,676	9,906	8,304	30,886	-[2]	-[2]	-[2]	-	28,450	59,336
1983	16,768	6,442	7,741	30,951	8,511	34,054	797	-	43,362	74,313
1984	8,603	3,732	4,972	17,307	12,772	15,334	884	-	28,990	46,297
1985	3,579	2,143	3,698	9,420	16,612	16,555	949	-	34,109	43,529
1986	-[2]	-[2]	-[2]	28,526	9,464	32,878	481	143	42,967	71,493
1987	11,457	6,744	3,244	21,445	-[2]	-[2]	-[2]	-[2]	33,193	54,648
1988	11,621	9,067	4,941	25,629	-[2]	-[2]	-[2]	-[2]	30,763	56,392
1989	12,517	8,203	4,511	25,231	-[2]	-[2]	-[2]	-[2]	31,170	56,401
1990	10,060	5,985	3,913	19,958	10,876	17,951	262	158	29,247	49,205
1991	9,437	5,003	3,056	17,497	9,681	18,019	187	127	28,014	45,511
1992	12,189	7,027	3,438	22,654	11,146	16,972	81	103	28,302	50,956
1993	14,706	4,679	6,363	25,747	14,506	16,897	124	154	31,681	57,428
1994	10,494	5,366	3,201	19,061	10,864	22,382	145	136	33,527	52,588
1995	12,620	2,945	2,133	17,698	11,589	23,125	162	107	34,983	52,681
1996	7,583	2,085	4,385	14,053	10,360	19,917	214	146	30,637	44,690
1997	9,446	5,332	1,958	16,736	8,140	31,582	169	143	40,034	56,770

[1]Estimated value.
[2]Not available by gear.

Table 7.2.2 Southern horse mackerel catches by quarter and area.

Country/Sub-division	Spain 8c-E, 8c-W, 9a-N			Unit:tonnes	Total
Quarter/ Year	1	2	3	4	
1984	-	-	-	-	28990
1985	-	-	-	-	34116
1986	-	-	-	-	42967
1987	5179	8678	11067	8269	33193
1988	6445	7936	7918	8464	30763
1989	7824	7480	8011	7855	31170
1990	6827	7871	7766	6783	29247
1991	5369	7220	8741	6686	28016
1992	4065	8750	10042	5445	28302
1993	5546	9227	9823	7085	31681
1994	6486	8966	9732	8343	33527
1995	6050	10328	10969	7636	34983
1996	7188	8045	8211	7193	30637
1997	6638	11132	13854	8410	40034

Country/ Sub-division	Portugal 9a-CN, 9a-CS, 9a-S			Unit:tonnes	Total
Quarter/ Year	1	2	3	4	
1984	4669	6506	3577	2358	17110
1985	1226	3055	2946	2192	9419
1986	4627	8093	7542	8264	28526
1987	3902	5474	6654	3524	19554
1988	3069	7402	7554	7100	25125
1989	4074	9096	8543	3513	25226
1990	3341	5753	5873	4992	19959
1991	3101	5630	5094	3672	17497
1992	2516	5661	7196	7281	22654
1993	5455	6401	8384	5507	25747
1994	4418	5051	6386	3206	19061
1995	3240	4618	6038	3802	17698
1996	2649	3830	4068	3506	14053
1997	4449	5370	4218	2699	16736

Table 7.3.1.1 Catch in numbers ('000) at age by quarter and by sub-division of SOUTHERN HORSE MACKEREL in 1998.

1998	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	0	0	0	0	0	0	0
1	2,499	21,849	10,535	40,627	69,748	32,136	177,393
2	161	1,599	1,319	1,828	1,151	868	6,926
3	1,789	489	2,152	178	273	159	5,040
4	1,838	318	684	636	1,034	593	5,102
5	1,547	614	497	578	534	410	4,181
6	714	633	269	430	293	274	2,613
7	961	1,002	348	198	131	118	2,759
8	1,286	1,529	481	39	28	25	3,389
9	790	1,044	330	61	44	40	2,309
10	1,635	2,035	752	52	36	35	4,546
11	1,010	1,346	557	25	18	16	2,973
12	380	507	251	17	10	11	1,176
13	126	174	146	17	10	10	484
14	2	42	62	39	24	23	193
15+	288	483	419	291	184	181	1,847
Total	15,027	33,665	18,802	45,016	73,518	34,900	220,929
Tonnes	2,310	2,709	1,619	1,443	1,956	1,050	11,087
SOP%	99	100	100	100	100	100	100

	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	0	0	0	0	0	0	0
1	18,624	1,422	10,508	26,268	12,846	8,448	78,115
2	2,417	9,139	7,654	23,448	13,645	8,690	64,993
3	6,895	4,630	4,311	6,024	2,915	2,117	26,892
4	3,852	1,584	776	2,086	1,118	854	10,270
5	2,517	1,966	399	1,476	523	424	7,305
6	1,094	1,578	223	513	158	137	3,702
7	1,333	2,324	283	171	52	47	4,210
8	1,546	3,080	394	120	43	40	5,222
9	664	1,757	289	94	37	36	2,878
10	1,763	3,737	643	71	34	33	6,282
11	611	2,304	626	55	27	27	3,651
12	192	876	329	42	28	31	1,498
13	66	393	218	54	27	29	786
14	17	143	126	76	27	26	414
15+	230	1,045	383	176	66	65	1,965
Total	41,821	35,979	27,161	60,674	31,548	21,003	218,185
Tonnes	3,529	5,426	2,178	2,908	1,443	1,019	16,503
SOP%	97	100	100	100	100	100	101

	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	638	874	299	57	15	19	1,903
1	22,849	28,923	13,377	15,680	9,674	9,425	99,927
2	4,387	17,452	4,211	8,353	4,575	4,638	43,617
3	1,890	6,321	1,892	1,074	499	508	12,183
4	1,437	4,594	1,910	1,037	626	571	10,176
5	1,086	2,027	1,330	887	517	508	6,355
6	619	720	654	576	235	310	3,113
7	395	615	1,004	601	249	326	3,190
8	1,265	1,151	1,954	182	65	93	4,710
9	263	606	1,324	132	52	66	2,442
10	845	1,423	2,845	121	52	61	5,347
11	496	1,065	2,510	146	47	64	4,329
12	9	264	539	98	28	38	977
13	5	146	366	0	0	0	518
14	1	58	150	0	0	0	209
15+	188	644	1,312	167	47	75	2,433
Total	36,374	66,883	35,678	29,111	16,679	16,703	201,427
Tonnes	2,618	6,125	5,111	2,030	1,066	1,122	18,072
SOP%	97	100	100	100	100	100	100

	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	2,792	557	757	1,207	684	654	6,650
1	7,004	3,250	2,132	3,237	3,296	2,531	21,449
2	3,336	9,729	2,016	8,545	10,773	7,489	41,887
3	851	9,810	1,067	817	846	625	14,016
4	772	6,112	710	836	499	467	9,397
5	953	2,048	683	346	205	222	4,458
6	523	648	432	117	69	84	1,973
7	468	429	522	44	33	50	1,545
8	1,597	912	1,105	23	20	36	3,694
9	431	463	579	28	26	50	1,577
10	1,122	1,089	1,242	12	12	22	3,499
11	730	743	998	4	4	7	2,485
12	33	142	174	3	2	5	359
13	16	95	117	8	7	15	257
14	4	30	28	7	7	14	89
15+	237	367	424	7	6	12	1,052
Total	20,967	36,422	12,987	15,240	16,489	12,283	114,388
Tonnes	2,059	4,353	1,998	935	991	773	11,109
SOP%	99	100	100	100	100	100	100

Table 7.3.1.2 Catch in numbers at age by year.

The SAS System 10:10 Thursday, October 1, 1998

HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

CANUM01: Catch in Numbers (Total International Catch) (Total) (Thousands)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7
1981	53700	315700	136200	58800	20400	47800	34800	23000
1982	104700	122600	115000	77700	27000	22200	28000	28300
1983	182300	1109100	74800	24400	22600	31500	34900	20600
1984	12200	71100	459700	40700	3800	8900	21600	20000
1985	393697	297486	84887	79849	26197	14665	7075	7363
1986	615298	425659	96999	64701	122560	27584	13610	24346
1987	53320	618570	170015	66303	28789	81020	21825	10485
1988	121951	271052	94945	39364	22598	20507	92897	17212
1989	242537	158646	70438	93590	37363	25474	22839	52657
1990	48100	164206	100833	60289	35931	14307	11786	12913
1991	31786	69544	71451	24222	33833	28678	13952	14578
1992	45629	285197	107761	51971	21596	23308	24973	14167
1993	10719	101326	262637	95182	35647	23159	22311	35258
1994	9435	113345	264744	93214	23624	11374	18612	22740
1995	3512	161142	124731	93349	47507	15997	11235	13608
1996	38345	35453	57096	41157	53002	27873	11580	11378
1997	8553	376888	157423	58132	34944	22297	11403	11704

Year	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14	Age 15
1981	24100	0	0	0	0	0	0	0
1982	27600	0	0	0	0	0	0	0
1983	20200	0	0	0	0	0	0	0
1984	18000	0	0	0	0	0	0	0
1985	3981	6270	4614	3214	2702	1699	864	4334
1986	12080	6694	8198	6349	5838	3244	2023	2963
1987	5042	3795	2337	1999	1666	951	1029	1906
1988	11669	10279	7042	4523	6050	2514	1379	3717
1989	11308	14892	11182	2728	2243	4266	1456	3791
1990	76713	9463	6562	3481	2568	2017	2430	4409
1991	11948	64501	8641	5671	3933	1970	2113	2164
1992	11384	12496	52251	4989	4043	2480	1815	4045
1993	11881	15094	5813	36062	1653	879	823	2304
1994	26587	8207	5142	2546	10266	1291	1001	1210
1995	19931	16763	8550	5664	4846	11717	2367	2809
1996	8384	19061	14339	6302	5896	3923	9571	4317
1997	17014	9206	19672	13436	4009	2045	906	7297

Table 7.3.2.1 Length (cm) at age by quarter and by sub-division of SOUTHERN HORSE MACKEREL in 1998.

1998	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	12.7	12.8	14.0	13.7	13.5	13.5	13.4
2	15.9	16.1	15.6	16.9	16.9	16.9	16.4
3	23.9	21.1	20.9	21.9	21.9	21.9	22.1
4	26.0	26.2	24.6	22.8	22.7	22.8	24.4
5	27.1	27.7	27.2	24.9	24.6	24.8	26.4
6	28.3	28.6	28.3	26.2	26.2	26.2	27.6
7	28.9	29.2	28.9	28.0	28.0	28.0	28.9
8	29.6	29.8	29.7	29.5	29.4	29.5	29.7
9	30.8	30.9	31.3	29.9	29.9	29.9	30.9
10	29.8	30.6	31.4	30.2	30.2	30.2	30.4
11	31.8	31.8	33.4	29.8	29.7	29.8	32.1
12	32.2	32.5	34.2	31.3	31.2	31.2	32.7
13	33.3	34.0	35.9	32.0	32.0	32.0	34.2
14	36.8	36.9	38.0	32.6	32.6	32.5	35.3
15+	31.4	34.0	37.8	36.4	36.5	36.6	35.3
0-15+	25.5	18.1	19.1	14.5	13.9	14.3	16.0

	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	13.5	17.3	15.7	13.7	13.5	13.5	13.9
2	16.2	18.0	17.1	16.9	16.9	16.9	17.1
3	23.1	20.4	20.6	21.9	21.9	21.9	21.7
4	25.4	25.6	23.6	22.8	22.7	22.8	24.3
5	27.0	27.5	27.3	24.9	24.6	24.8	26.4
6	28.3	28.5	28.3	26.2	26.2	26.2	27.9
7	28.7	29.0	28.9	28.0	28.0	28.0	28.9
8	29.1	29.5	30.0	29.5	29.4	29.5	29.4
9	30.2	30.8	32.3	29.9	29.9	29.9	30.7
10	29.2	30.5	32.3	30.2	30.2	30.2	30.3
11	31.3	32.2	34.4	29.8	29.7	29.8	32.4
12	32.4	33.2	35.2	31.3	31.2	31.2	33.4
13	34.6	35.1	35.5	32.0	32.0	32.0	34.7
14	36.3	37.6	37.6	32.6	32.6	32.5	36.0
15+	31.2	34.6	37.5	36.4	36.5	36.6	35.1
0-15+	20.0	25.3	19.5	16.7	16.5	16.7	19.1

	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	length (cm)	length (cm)	length (cm)	length (cm)	length (cm)	length (cm)	length(cm)
0	12.5	13.3	12.9	13.6	13.5	13.6	13.0
1	17.3	18.8	17.7	17.0	17.1	17.1	17.7
2	20.1	20.0	20.4	18.3	17.9	18.0	19.3
3	23.8	23.9	24.3	21.2	21.7	21.4	23.5
4	25.1	24.9	25.4	23.8	24.0	23.9	24.8
5	27.0	26.4	26.6	25.5	25.1	25.4	26.2
6	27.6	27.2	27.5	27.4	27.4	27.4	27.4
7	28.5	30.4	31.4	28.5	28.6	28.5	29.8
8	29.1	30.0	30.5	30.4	30.3	30.3	30.0
9	30.2	32.9	32.7	31.1	31.0	30.9	32.3
10	29.3	31.4	32.1	31.9	31.5	31.6	31.4
11	30.2	32.7	32.7	34.7	34.0	34.3	32.5
12	36.8	36.2	36.7	34.0	33.8	33.9	36.1
13	37.7	36.9	37.4	0.0	0.0	0.0	37.3
14	38.4	37.8	38.6	0.0	0.0	0.0	38.4
15+	29.4	34.5	35.5	39.4	40.0	40.7	35.3
0-15+	19.8	21.4	24.3	19.0	18.6	18.8	20.8

	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	12.2	11.7	11.9	14.7	15.0	14.8	13.1
1	18.3	20.2	18.2	17.2	17.4	17.4	18.2
2	20.2	21.5	21.0	18.5	18.5	18.4	19.4
3	23.7	23.7	23.4	19.9	19.4	19.6	23.0
4	25.6	24.8	25.3	23.0	23.0	23.1	24.5
5	27.1	26.1	27.1	24.7	24.7	24.8	26.2
6	27.8	27.0	27.6	27.0	27.1	27.1	27.4
7	29.0	31.0	30.7	29.4	29.7	30.1	30.2
8	29.3	29.9	29.8	31.7	32.0	32.3	29.7
9	30.7	32.6	32.4	32.6	32.7	32.8	32.0
10	29.8	31.1	31.3	32.8	32.8	32.9	30.8
11	30.6	32.3	32.2	32.0	32.0	32.0	31.8
12	35.2	35.6	36.1	35.0	35.0	35.0	35.8
13	34.6	36.0	36.4	34.5	34.5	34.5	35.9
14	36.1	37.3	38.4	35.5	35.4	35.4	37.0
15+	30.1	34.0	34.0	36.4	36.4	36.3	33.2
0-15+	21.5	23.9	25.3	18.5	18.5	18.7	21.6

Table 7.3.2.2 Weight (g) at age by quarter and by sub-division of SOUTHERN HORSE MACKEREL in 1998.

1998	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)
0	0	0	0	0	0	0	0
1	19	19	25	23	22	22	22
2	36	37	34	43	42	43	40
3	111	79	77	88	89	89	91
4	142	145	124	100	98	99	121
5	160	170	162	128	124	126	149
6	180	185	180	149	148	149	169
7	191	197	191	180	180	180	191
8	206	210	208	210	209	209	208
9	231	233	241	217	217	217	233
10	211	226	251	225	224	225	225
11	252	253	294	216	214	215	260
12	261	270	314	248	247	247	276
13	287	306	358	265	265	265	314
14	382	384	420	280	279	278	349
15+	244	320	424	389	392	397	357
0-15+	155	80	86	32	27	30	50

	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)
0	0	0	0	0	0	0	0
1	22	45	34	33	32	32	30
2	38	50	43	40	39	39	41
3	102	72	73	62	65	66	76
4	134	138	111	109	107	107	123
5	158	166	162	136	133	134	153
6	180	184	181	153	153	154	176
7	187	194	192	180	180	180	191
8	196	204	216	199	199	199	203
9	219	230	266	220	220	220	231
10	199	226	272	242	242	242	224
11	243	265	318	265	265	265	270
12	266	289	339	290	290	290	297
13	320	336	348	316	316	316	335
14	367	407	406	344	344	344	386
15+	243	336	412	429	432	433	355
0-15+	87	151	80	48	46	49	76

	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	weight (g)	weight (g)	weight (g)	weight (g)	weight (g)	weight (g)	weight(g)
0	18	21	20	25	25	25	20
1	45	56	48	47	47	47	49
2	68	67	71	57	53	54	63
3	111	112	117	86	93	89	109
4	129	125	132	117	119	119	126
5	157	147	151	141	136	140	147
6	168	162	167	173	173	173	168
7	185	225	246	193	194	193	215
8	195	216	226	232	229	229	216
9	218	279	276	246	243	243	267
10	201	249	262	264	256	258	249
11	218	276	275	340	321	329	272
12	384	367	382	316	311	314	367
13	410	389	405	0	0	0	400
14	434	416	442	0	0	0	435
15+	206	331	356	492	516	546	356
0-15+	74	91	143	70	64	67	90

	VIIIc East	VIIIc West	IXa North	IXa Centr-N	IXa Centr-S	IXa South	All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)	weight(g)
0	17	15	16	31	33	32	22
1	52	70	52	47	50	49	53
2	69	82	78	58	58	58	65
3	110	109	106	72	67	69	102
4	137	123	132	106	106	107	122
5	160	143	159	130	130	131	147
6	171	158	168	166	167	168	166
7	196	237	231	212	219	227	221
8	200	213	212	263	268	274	208
9	229	272	267	282	284	286	259
10	212	241	245	286	286	288	234
11	226	266	263	265	265	265	253
12	338	348	363	342	341	341	354
13	322	363	374	330	329	329	361
14	362	400	436	357	355	355	396
15+	219	317	317	387	389	383	296
0-15+	99	119	154	61	60	63	97

Table 7.3.2.3 Southern horse mackerel mean weight at age

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HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

WECA01: Mean Weight in Catch (Total International Catch) (Total) (Kilograms)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7
1981	0.02300	0.04000	0.06700	0.09700	0.17400	0.25400	0.29200	0.34100
1982	0.02000	0.03300	0.08200	0.11500	0.15200	0.22600	0.26100	0.29600
1983	0.01300	0.02800	0.06100	0.12500	0.15900	0.22500	0.26700	0.29400
1984	0.01500	0.02500	0.04900	0.08000	0.12400	0.17800	0.24600	0.27500
1985	0.01400	0.02700	0.07000	0.09100	0.11700	0.13200	0.15200	0.18200
1986	0.01600	0.02900	0.05500	0.07600	0.10400	0.13700	0.18500	0.19400
1987	0.02438	0.03103	0.04907	0.05773	0.09611	0.10599	0.13089	0.16139
1988	0.02675	0.03620	0.06615	0.08189	0.11089	0.12563	0.15601	0.15642
1989	0.01552	0.04060	0.06185	0.08931	0.10854	0.13226	0.15202	0.18910
1990	0.01627	0.03514	0.04741	0.07572	0.12389	0.13047	0.15456	0.16970
1991	0.01602	0.03339	0.06310	0.10214	0.13343	0.15142	0.16788	0.17345
1992	0.01800	0.02900	0.04800	0.07800	0.10500	0.14100	0.16200	0.17300
1993	0.01500	0.03400	0.04000	0.06400	0.10900	0.15500	0.17100	0.20200
1994	0.02100	0.03600	0.05800	0.06900	0.09700	0.14200	0.18200	0.20500
1995	0.02900	0.03600	0.05800	0.09100	0.11000	0.13900	0.17300	0.18900
1996	0.01300	0.02900	0.06600	0.10400	0.13000	0.15400	0.18100	0.20600
1997	0.02200	0.03300	0.05400	0.09100	0.12300	0.14900	0.17100	0.20200

Year	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14	Age 15
1981	0.40700	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000
1982	0.36300	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000
1983	0.36100	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000
1984	0.33100	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000	-1.00000
1985	0.24900	0.26400	0.28400	0.31200	0.32000	0.34400	0.35700	0.37800
1986	0.20900	0.29000	0.30100	0.31900	0.32900	0.33900	0.34900	0.34900
1987	0.19782	0.21087	0.24560	0.30215	0.28754	0.35218	0.36110	0.35816
1988	0.20171	0.23866	0.24866	0.27488	0.31379	0.33343	0.32738	0.35506
1989	0.19973	0.20304	0.24761	0.31987	0.34492	0.35909	0.37478	0.38929
1990	0.18229	0.21408	0.25974	0.27211	0.31612	0.34461	0.36809	0.38845
1991	0.19267	0.19640	0.23322	0.23563	0.28031	0.30412	0.32301	0.37211
1992	0.18200	0.19100	0.21400	0.24000	0.27800	0.31300	0.34100	0.38700
1993	0.22500	0.22500	0.25500	0.25000	0.32100	0.36400	0.39700	0.46100
1994	0.22600	0.25000	0.27600	0.29900	0.29500	0.34300	0.36300	0.39100
1995	0.21800	0.23500	0.27300	0.29100	0.30500	0.29000	0.36200	0.39200
1996	0.21200	0.22600	0.25700	0.27900	0.26000	0.31300	0.31000	0.44100
1997	0.20900	0.24600	0.23300	0.26500	0.31300	0.35000	0.39000	0.34700

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HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

WEST01: Mean Weight in Stock (Total International Catch) (Total) (Kilograms)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14	Age 15
1981	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1982	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1983	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1984	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1985	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1986	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1987	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1988	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1989	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1990	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1991	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1992	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1993	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1994	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1995	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1996	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1997	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381

Table 7.4.1.1 SOUTHERN HORSE MACKEREL. CPUE indices from research surveys.

	Portugal IXa (20-500 m depth)			Spain (20-500m depth)
	Bottom trawl (20-mm codend)			
Year	Kg/h March	kg/h Jun-Jul	kg/h Oct	kg/30 minutes Sept-Oct
1979		12.2	5.5[1]	-
1980		20.6	2.5[1]	-
1981		11.6	1.8	-
1982		42.1	36.9	-
1983		79.1	24.6	37.97
1984		-	-	51.98
1985		9.5	3.8	20.93
1986		4.8	23.5	10.14
1987		-	6.9	-
1988		-	26.0	12.05
1989		14.9	11.7	15.48
1990		14.4	21.5	9.62
1991		11.8	16.9	4.92
1992	17.5	38.0	40.8	20.30
1993	100.24	35.6	235.3	18.11
1994	_	49.3	12.4	21.61
1995	_	9.8	18.9	21.99
1996	_	_	23.25	26.75
1997	_	21.0	59.6	14.43

Table 7.4.1.2 CPUE at age from surveys

The SAS System 11:59 Thursday, October 1, 1998
HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

FLT13: Oct Pt Survey (Catch: Number)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7
1985	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	1	706.196	123.479	82.500	70.046	12.621	2.445	0.313	0.552
1987	1	95.243	24.377	29.541	12.419	9.802	5.673	1.163	0.519
1988	1	29.416	704.046	54.984	20.207	13.920	6.472	21.741	8.294
1989	1	377.665	93.538	40.406	20.064	6.196	3.956	3.847	2.395
1990	1	508.494	269.582	28.907	16.472	17.014	9.822	1.794	1.187
1991	1	336.245	97.414	14.704	13.411	14.272	6.571	3.895	2.275
1992	1	677.806	500.049	184.896	34.300	15.932	8.153	6.113	6.745
1993	1	1733.340	214.230	328.440	111.630	37.010	2.160	0.950	0.950
1994	1	4.217	9.499	75.879	44.908	19.693	5.142	2.013	1.022
1995	1	6.972	9.386	148.650	56.402	26.310	8.156	3.383	0.709
1996	1	1225.000	5.750	6.979	16.346	19.530	8.052	2.129	0.592
1997	1	2832.548	21.619	110.750	18.102	51.410	67.224	19.203	14.257

Year	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1985	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.003
1986	0.370	0.238	0.189	0.286	0.181	0.126	0.051	0.115
1987	0.487	0.368	0.225	0.165	0.248	0.047	0.022	0.019
1988	1.834	0.878	0.298	0.030	0.001	0.001	0.001	0.001
1989	0.662	0.320	0.430	0.398	0.162	0.139	0.012	0.004
1990	3.577	2.600	1.532	0.624	0.770	0.266	0.239	0.179
1991	2.331	1.951	1.006	0.405	0.350	0.238	0.220	0.185
1992	4.196	3.251	3.805	0.497	0.702	0.178	0.082	0.086
1993	0.670	0.860	0.570	1.340	0.370	0.220	0.070	0.050
1994	0.850	0.534	0.234	0.189	0.126	0.089	0.053	0.030
1995	0.527	0.383	0.260	0.219	0.227	0.228	0.221	0.215
1996	0.209	0.135	0.106	0.062	0.047	0.031	0.005	0.005
1997	5.914	6.939	2.386	0.109	0.018	0.126	0.079	0.054

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HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

FLT14: Oct Sp. Survey,bottom trawl survey (Catch: Number)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7
1985	1	182.630	84.360	322.510	467.600	7.090	6.500	4.710	4.050
1986	1	289.420	44.600	12.640	7.000	41.810	4.920	5.150	11.110
1987	1	217.665	64.153	20.035	8.053	18.482	16.448	5.100	7.979
1988	1	145.910	14.650	14.220	9.000	5.130	8.170	54.990	5.050
1989	1	115.000	6.540	1.900	21.300	4.680	17.500	15.620	65.040
1990	1	26.620	17.790	2.730	2.680	15.920	5.680	7.630	6.090
1991	1	48.470	15.370	5.100	0.150	1.440	1.820	0.710	0.640
1992	1	85.470	44.810	0.740	1.050	0.350	2.080	4.470	4.360
1993	1	138.619	31.848	3.447	0.630	2.199	4.546	13.762	17.072
1994	1	937.761	64.849	20.936	1.332	1.510	2.535	4.887	9.632
1995	1	38.308	172.564	12.492	6.941	5.806	3.845	6.311	9.659
1996	1	43.288	47.240	26.844	19.573	35.014	19.058	6.602	11.004
1997	1	13.866	21.891	6.529	9.419	7.730	6.327	3.911	3.995

Year	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1985	4.840	5.390	3.580	0.880	0.840	0.260	0.770	5.010
1986	4.680	7.200	8.540	3.050	1.310	0.800	0.980	3.840
1987	5.662	5.879	4.712	4.630	1.470	1.389	4.147	0.001
1988	5.730	6.850	4.800	2.600	7.030	1.650	2.410	17.550
1989	7.680	10.470	26.160	0.570	0.410	4.770	0.400	5.440
1990	73.350	3.050	4.730	0.860	0.810	0.600	0.770	1.670
1991	2.170	28.900	6.420	6.520	2.220	1.070	2.780	0.640
1992	5.730	5.090	47.600	5.060	1.620	0.600	0.180	3.550
1993	4.513	4.422	3.881	22.057	0.235	0.041	0.228	0.256
1994	11.578	2.473	1.530	0.911	4.512	0.361	0.194	0.433
1995	14.481	11.868	3.503	1.930	0.340	8.609	0.101	0.049
1996	2.733	21.892	7.012	1.079	1.723	0.033	3.657	0.078
1997	12.424	3.947	10.330	7.708	0.506	0.350	0.109	2.585

Table 7.4.1.2 (cont.) CPUE at age from surveys

HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

FLT15: Jul Pt. Survey, bottom trawl survey (Catch: Number)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7
1989	1	81.91291	38.35600	45.52200	60.64800	26.99800	5.84600	3.16400	6.63400
1990	1	82.17500	51.60500	69.39700	26.15700	12.39300	5.58800	3.67000	3.51500
1991	1	17.42900	53.09400	19.47900	3.50700	3.90600	3.97800	2.49500	3.12800
1992	1	109.17800	1822.95000	39.70100	21.08100	7.98000	5.01300	3.42700	3.34800
1993	1	1.81000	263.39000	263.80000	150.04000	20.84000	39.56000	89.15000	31.34000
1994	1	54.98100	408.26200	232.99500	110.93500	49.98800	34.72400	38.43800	20.98500
1995	1	5.41000	38.57100	16.13200	23.07100	26.69900	12.23300	5.57700	2.07100
1996	0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1997	1	29.13900	330.30500	71.13100	8.19900	11.93200	4.99300	1.96900	1.37100

Year	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1989	3.04200	3.71600	1.44000	0.79300	0.61300	0.21400	0.15700	0.24400
1990	7.74500	3.00100	1.36300	0.69500	0.75800	0.44500	0.35600	0.47000
1991	3.56600	7.63700	3.53700	3.57400	2.28800	2.49100	0.50800	0.41300
1992	3.87900	5.61600	9.99800	3.98800	5.77200	3.20500	1.03800	0.48100
1993	22.69000	9.53000	0.52000	0.64000	0.05000	0.02000	0.00000	0.00000
1994	5.72500	3.90500	3.55000	3.19300	5.48500	1.88300	1.05700	0.86700
1995	0.54000	0.27000	0.22300	0.15800	0.26300	0.11500	0.09100	0.10300
1996	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1997	0.24900	0.16900	0.17000	0.46200	0.05400	0.00000	0.00000	0.01200

Table 7.5.1 SOUTHERN HORSE MACKEREL. CPUE series in commercial fisheries.

Year	Division IXa (Portugal)	Division VIIIc (Spain)	
	Trawl	Trawl	
		Sub-div. VIIIc East Aviles	Sub-div. VIIIc West La Coruña
	kg/h	kg/Hp.day. 10^{-2}	kg/Hp.day.10^{-2}
1979	87.7	-	-
1980	69.3	-	-
1981	59.1	-	-
1982	56.2	-	-
1983	98.0	123.46	90.4
1984	55.9	142.94	135.87
1985	24.4	131.22	118.00
1986	41.6	116.90	130.84
1987	71.0	109.02	176.65
1988	91.1	88.96	146.63
1989	69.5	98.24	172.84
1990	98.9	125.35	146.27
1991	n.a.	106.42	145.09
1992	n.a.	73.70	163.12
1993	n.a.	71.47	200.50
1994	n.a.	137.56	136.75
1995	n.a.	130.44	124.11
1996	n.a.	145.64	156.50
1997	n.a.	89.56	117.39

Table 7.5.2 CPUE at age from fleets

The SAS System 11:59 Thursday, October 1, 1998
HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

FLT11: 8c West trawl fleet (La Coruna) (Catch: Millions)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1984	32427	1	356	644	124	38	38	8	87	30	42	5	6	1	6	3	12
1985	30255	3	12	134	399	19	42	39	25	27	43	22	8	3	1	3	27
1986	26540	3	79	58	118	400	40	31	22	15	15	41	16	6	10	2	33
1987	23122	1	33	113	92	143	672	76	61	13	22	20	16	8	2	1	13
1988	28119	5	167	258	58	58	51	408	40	29	22	11	11	16	4	2	9
1989	29628	23	152	48	115	56	57	38	299	40	103	78	6	2	23	2	16
1990	29578	1	84	128	37	71	17	27	39	394	21	27	5	6	6	7	15
1991	26959	1	1	41	2	20	39	27	65	49	376	37	17	12	2	9	5
1992	26199	0	191	60	10	9	54	99	48	46	51	361	12	6	3	0	8
1993	29670	0	34	467	39	51	95	87	210	56	79	16	209	1	0	1	1
1994	26393	2	79	270	12	8	20	92	146	165	34	18	4	45	1	0	1
1995	28000	0	7	122	84	37	25	36	64	129	102	33	12	2	47	1	1
1996	23818	0	1	29	14	65	89	51	62	41	125	108	36	15	14	59	3
1997	23668	0	2	3	2	6	13	14	32	52	49	86	80	34	18	6	40

The SAS System 11:59 Thursday, October 1, 1998
HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

FLT12: 8c East trawl fleet (Aviles) (Catch: Millions)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1984	10185	4	882	759	141	42	39	11	65	18	31	3	4	1	6	3	11
1985	9856	1	167	613	574	13	18	16	13	17	21	14	4	4	1	4	19
1986	10845	36	223	271	174	527	42	19	14	10	8	9	2	1	1	0	2
1987	8309	1	244	350	166	48	396	40	19	7	9	6	5	3	1	1	4
1988	9047	181	264	53	23	18	19	148	14	17	22	15	12	22	6	5	27
1989	8063	65	275	62	105	50	42	18	100	13	38	35	1	1	18	2	15
1990	8492	1	726	373	257	72	19	21	24	192	10	13	3	4	4	4	9
1991	7677	39	495	882	41	85	51	10	12	9	67	3	2	1	1	1	1
1992	12693	2	35	21	65	34	60	63	20	16	19	114	3	1	1	0	7
1993	7635	0	215	462	77	44	23	18	42	6	14	2	35	1	0	0	1
1994	9620	1	47	632	12	6	17	69	118	135	25	14	3	38	1	0	0
1995	6146	1	182	441	141	70	32	25	39	89	71	31	12	4	37	1	1
1996	4525	0	225	608	129	230	128	32	24	22	49	32	10	4	4	17	0
1997	5061	0	48	10	15	34	43	36	49	83	34	76	42	8	2	0	14

Table 7.7.2.1 XSA diagnostics.

Lowestoft VPA Version 3.1
1-Oct-98 16:40:11
Extended Survivors Analysis
S. horse mackerel (run: XSAPAB03/X03)
CPUE data from file /users/fish/ifad/ifapwork/wgmhsa/hom_soth/FLEET.X03
Catch data for 13 years. 1985 to 1997. Ages 0 to 12.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT06: 8c West trawl	1985	1997	0	11	0	1
FLT07: 8c East trawl	1985	1997	0	11	0	1
FLT08: Oct Pt Survey	1985	1997	0	11	0.8	0.9
FLT09: Oct Sp. Surve	1985	1997	0	11	0.79	0.88
FLT10: Jul Pt. Surve	1989	1997	0	11	0.54	0.63

Time series weights :
Tapered time weighting applied
Power = 3 over 20 years
Catchability analysis :
Catchability dependent on stock size for ages < 2
Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 2
Catchability independent of age for ages >= 9
Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.
S.E. of the mean to which the estimates are shrunk = 1.000
Minimum standard error for population
estimates derived from each fleet = .300
Prior weighting not applied
Tuning had not converged after 60 iterations
Total absolute residual between iterations
59 and 60 = .00350
Final year F values

Age	0	1	2	3	4	5	6	7	8	9
Iteration 59	0.0064	0.4194	0.5975	0.3314	0.0854	0.0675	0.0335	0.0809	0.1536	0.1546
Iteration 60	0.0064	0.4189	0.5961	0.3307	0.0852	0.0674	0.0335	0.0808	0.1535	0.1545
Age	10	11								

Table 7.7.2.1 (cont.)

Iteration 59	0.2286	0.2175
Iteration 60	0.2285	0.2174

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	0.141	0.235	0.051	0.017	0.031	0.009	0.016	0.007	0.03	0.006
1	0.276	0.259	0.234	0.093	0.2	0.085	0.122	0.383	0.083	0.419
2	0.119	0.101	0.246	0.143	0.192	0.27	0.315	0.182	0.214	0.596
3	0.147	0.157	0.111	0.081	0.139	0.245	0.137	0.164	0.08	0.331
4	0.11	0.192	0.079	0.08	0.092	0.127	0.084	0.091	0.125	0.085
5	0.147	0.165	0.099	0.079	0.069	0.127	0.051	0.071	0.067	0.067
6	0.118	0.229	0.102	0.125	0.087	0.083	0.136	0.062	0.064	0.034
7	0.201	0.086	0.185	0.167	0.171	0.161	0.108	0.132	0.079	0.081
8	0.152	0.187	0.165	0.247	0.18	0.2	0.167	0.123	0.106	0.153
9	0.283	0.279	0.222	0.193	0.416	0.363	0.196	0.142	0.157	0.154
10	0.514	0.535	0.18	0.307	0.224	0.327	0.19	0.304	0.165	0.229
11	0.326	0.36	0.295	0.221	0.276	0.224	0.219	0.312	0.362	0.217
1										

XSA population numbers (Thousands)

AGE YEAR	0	1	2	3	4	5	6	7	8	9
1988	1.00E+06	1.21E+06	9.09E+05	3.11E+05	2.34E+05	1.62E+05	8.99E+05	1.02E+05	8.92E+04	4.49E+04
1989	1.25E+06	7.49E+05	7.92E+05	6.94E+05	2.31E+05	1.80E+05	1.20E+05	6.88E+05	7.16E+04	6.59E+04
1990	1.03E+06	8.49E+05	4.98E+05	6.16E+05	5.11E+05	1.64E+05	1.31E+05	8.23E+04	5.43E+05	5.12E+04
1991	2.00E+06	8.46E+05	5.78E+05	3.35E+05	4.74E+05	4.06E+05	1.28E+05	1.02E+05	5.89E+04	3.96E+05
1992	1.60E+06	1.70E+06	6.64E+05	4.31E+05	2.66E+05	3.77E+05	3.23E+05	9.73E+04	7.44E+04	3.96E+04
1993	1.25E+06	1.34E+06	1.20E+06	4.71E+05	3.23E+05	2.09E+05	3.03E+05	2.55E+05	7.06E+04	5.35E+04
1994	6.44E+05	1.06E+06	1.06E+06	7.85E+05	3.17E+05	2.45E+05	1.58E+05	2.40E+05	1.87E+05	4.97E+04
1995	5.58E+05	5.46E+05	8.09E+05	6.64E+05	5.89E+05	2.51E+05	2.00E+05	1.19E+05	1.85E+05	1.36E+05
1996	1.42E+06	4.77E+05	3.20E+05	5.80E+05	4.85E+05	4.63E+05	2.01E+05	1.62E+05	8.96E+04	1.41E+05
1997	1.44E+06	1.19E+06	3.78E+05	2.23E+05	4.61E+05	3.69E+05	3.73E+05	1.63E+05	1.29E+05	6.93E+04

Estimated population abundance at 1st Jan 1998

0.00E+00	1.23E+06	6.73E+05	1.80E+05	1.38E+05	3.65E+05	2.97E+05	3.10E+05	1.29E+05	9.52E+04

Taper weighted geometric mean of the VPA populations:

Table 7.7.2.1 (cont.)

	1.23E+06	9.69E+05	6.33E+05	4.87E+05	3.83E+05	2.84E+05	2.10E+05	1.45E+05	1.01E+05	6.94E+04

Standard error of the weighted Log(VPA populations) :

	0.4289	0.4042	0.4162	0.4887	0.4779	0.5237	0.5762	0.6163	0.6962	0.7376

	AGE	
YEAR	10	11
1988	1.89E+04	1.75E+04
1989	2.91E+04	9.73E+03
1990	4.29E+04	1.47E+04
1991	3.53E+04	3.09E+04
1992	2.81E+05	2.23E+04
1993	2.25E+04	1.94E+05
1994	3.20E+04	1.40E+04
1995	3.52E+04	2.28E+04
1996	1.02E+05	2.24E+04
1997	1.04E+05	7.41E+04

Estimated population abundance at 1st Jan 1998

5.12E+04	7.11E+04

Taper weighted geometric mean of the VPA populations:

4.55E+04	2.62E+04

Standard error of the weighted Log(VPA populations) :

0.7979	0.8315

Log catchability residuals.

Fleet : FLT06: 8c West trawl

Age	1985	1986	1987
0	99.99	99.99	99.99
1	-0.15	0.45	-0.3
2	0.74	-0.03	0.78
3	1.31	2.01	1.84
4	-0.26	1.16	2.19
5	0.23	0.31	1.47
6	0.18	-0.15	0.97
7	-0.17	-0.56	0.29
8	-0.04	-0.37	-0.78

Table 7.7.2.1 (cont.)

9	-0.11	-0.6	0.15
10	-0.3	0.33	0.16
11	-0.4	-0.07	-0.13

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	0.56	0.98	0.63	-1.05	0.29	-0.2	0.41	0.17	-0.43	-1.02
2	0.76	-0.84	0.67	-0.57	-0.28	1.1	0.81	0.16	-0.17	-2.42
3	1.24	1.07	0.04	-2.19	-0.78	0.42	-1.2	0.86	-0.67	-1.53
4	1.01	0.97	0.36	-0.74	-0.92	0.51	-1.23	-0.37	0.56	-1.78
5	0.67	0.63	-0.52	-0.51	-0.08	0.98	-0.66	-0.51	0.3	-1.38
6	0.57	0.21	-0.28	-0.15	0.24	0.05	0.89	-0.37	0.13	-1.79
7	-0.16	-0.17	-0.04	0.34	0.12	0.5	0.29	0.12	-0.08	-0.74
8	-0.59	-0.09	0.17	0.44	0.14	0.27	0.48	0.16	-0.1	-0.2
9	-0.54	0.57	-0.79	0.12	0.56	0.55	-0.18	-0.17	0.16	-0.06
10	-0.26	1.22	-0.39	0.28	0.47	-0.2	-0.38	0.12	0.35	0.13
11	-0.27	-0.32	-0.95	-0.41	-0.38	0.17	-1.04	-0.45	0.85	0.39

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	-19.0424	-19.9273	-19.4239	-18.833	-18.3849	-17.7512	-17.5381	-17.119	-17.119	-17.119
S.E(Log q)	1.0104	1.3289	1.1113	0.7934	0.7219	0.3627	0.3678	0.4426	0.4634	0.5907

Regression statistics :
Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	0	0	0	0	0	0	0
1	0.38	1.169	16.45	0.28	13	0.68	-20.76

Ages with q independent of year class strength and constant w.r.t. time.

Table 7.7.2.1 (cont.)

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.43	1.911	15.83	0.56	13	0.39	-19.04
3	0.63	0.675	17.37	0.27	13	0.86	-19.93
4	1.35	-0.336	21.71	0.09	13	1.57	-19.42
5	0.86	0.318	17.97	0.37	13	0.72	-18.83
6	1.27	-0.523	20.06	0.29	13	0.95	-18.38
7	0.96	0.224	17.5	0.76	13	0.37	-17.75
8	0.85	1.019	16.67	0.85	13	0.31	-17.54
9	0.94	0.322	16.76	0.76	13	0.44	-17.12
10	0.86	0.938	16.1	0.83	13	0.38	-17
11	0.75	1.753	15.56	0.85	13	0.37	-17.34
1							

Fleet : FLT07: 8c East trawl

Age	1985	1986	1987
0	99.99	99.99	99.99
1	99.99	99.99	99.99
2	99.99	99.99	99.99
3	99.99	99.99	99.99
4	99.99	99.99	99.99
5	-0.65	0.11	0.82
6	-0.3	-0.46	0.64
7	-0.16	-0.56	-0.31
8	0.13	-0.37	-0.87
9	-0.13	-0.76	-0.15
10	-0.05	-0.71	-0.45
11	-0.4	-1.68	-0.7

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	-0.33	0.48	-0.3	-0.13	-0.4	-0.23	-0.96	0.1	1.18	0.21
6	-0.02	0.05	0.01	-0.6	-0.2	-0.89	0.9	0.06	0.61	-0.01

Table 7.7.2.1 (cont.)

7	-0.53	-0.42	0.27	-0.54	-0.48	-0.2	0.64	0.69	0.18	0.78
8	-0.48	-0.39	0.21	-0.49	-0.68	-1.09	0.8	0.82	0.45	1.32
9	0.17	0.45	-0.71	-0.77	-0.13	-0.25	0.09	0.55	0.46	0.69
10	0.76	1.3	-0.29	-1.4	-0.38	-1.35	-0.05	1.15	0.37	1.13
11	0.52	-1.24	-0.63	-1.72	-1.46	-0.68	-0.74	0.64	0.81	0.87

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	0	0	0	-17.6872	-17.672	-17.2987	-17.0528	-16.6941	-16.6941	-16.6941
S.E(Log q)	0	0	0	0.599	0.5248	0.5216	0.7746	0.5112	0.9365	1.0689

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0.63	1.843	15.77	0.73	13	0.34	-17.69
6	1.16	-0.454	18.53	0.48	13	0.63	-17.67
7	0.93	0.256	16.94	0.62	13	0.51	-17.3
8	0.62	2.003	14.94	0.75	13	0.42	-17.05
9	0.98	0.087	16.58	0.68	13	0.53	-16.69
10	0.88	0.354	15.95	0.49	13	0.86	-16.67
11	0.85	0.476	16.07	0.52	13	0.85	-17.14

Fleet : FLT08: Oct Pt Survey

Table 7.7.2.1 (cont.)

Age	1985	1986	1987
0	99.99	-0.45	-0.41
1	99.99	0.3	-0.88
2	99.99	0.57	-0.38
3	99.99	1.32	-0.47
4	99.99	-1.7	-0.01
5	99.99	-0.61	-1.61
6	99.99	-1.92	-0.5
7	99.99	-0.52	-0.98
8	99.99	-0.08	-0.31
9	99.99	-0.53	0.11
10	99.99	-0.82	-0.3
11	99.99	0.16	-0.69

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	-0.3	0.14	0.36	-0.41	-0.01	0.48	-0.38	-0.11	0.26	0.46
1	0.85	0.46	0.78	0.29	0.34	0.17	-0.93	-0.18	-0.37	-0.58
2	-0.52	-0.71	-0.46	-1.37	1.07	1.12	-0.19	0.64	-1.46	1.46
3	0.04	-0.76	-0.88	-0.5	0.23	1.41	-0.1	0.32	-0.86	0.42
4	0.24	-0.49	-0.37	-0.47	0.23	0.9	0.25	-0.07	-0.14	0.84
5	0.53	-0.06	0.89	-0.43	-0.15	-0.84	-0.2	0.26	-0.37	1.98
6	0.53	0.9	-0.05	0.77	0.26	-1.54	-0.1	0.12	-0.34	1.22
7	1.99	-1.26	0.25	0.67	1.81	-1.13	-1.04	-0.68	-1.22	1.96
8	0.63	-0.14	-0.5	1.36	1.66	-0.11	-0.87	-1.38	-1.59	1.43
9	0.53	-0.87	1.43	-0.93	2.07	0.4	-0.15	-1.53	-2.6	2.05
10	0.51	0.46	1.04	0.93	0.11	0.82	-0.54	-0.43	-2.5	0.64
11	-1.87	1.33	1.32	0.08	0.65	-0.56	0.1	-0.16	-1.36	-2.12

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	-8.9611	-9.4265	-9.7434	-10.4028	-10.933	-11.1092	-11.1612	-11.0017	-11.0017	-11.0017
S.E(Log q)	1.0158	0.7647	0.6381	0.9096	0.9002	1.3255	1.1289	1.4896	1.0434	1.168

Table 7.7.2.1 (cont.)

Regression statistics :
Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	0.25	2.633	12.6	0.59	12	0.38	-8.42
1	0.43	1.147	11.87	0.32	12	0.63	-9.35

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.64	0.7	10.55	0.31	12	0.67	-8.96
3	2.53	-0.985	3.9	0.05	12	1.94	-9.43
4	3.41	-1.836	2.2	0.06	12	1.95	-9.74
5	2.47	-1.075	7.21	0.06	12	2.23	-10.4
6	0.83	0.386	11.16	0.38	12	0.78	-10.93
7	-8.38	-1.7	18.8	0	12	10.14	-11.11
8	2.31	-1.074	10.63	0.07	12	2.59	-11.16
9	-10.81	-1.932	12.9	0	12	14.19	-11
10	1.5	-0.784	11.14	0.22	12	1.6	-11.01
11	2.78	-1.574	13.19	0.08	12	2.92	-11.28

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Fleet : FLT09: Oct Sp. Surve

Age	1985	1986	1987
0	99.99	99.99	99.99
1	99.99	99.99	99.99
2	99.99	99.99	99.99
3	99.99	99.99	99.99
4	99.99	99.99	99.99
5	0.56	0.31	-0.31
6	0.28	0.16	0.25
7	0.34	1.04	0.31
8	0.36	0.55	0.24
9	0	0.76	0.76
10	0.08	0.87	0.62
11	-0.37	0.4	0.53

Table 7.7.2.1 (cont.)

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	0.99	1.66	0.57	-1.49	-1.29	0.13	-0.68	-0.27	0.72	-0.16
6	0.73	1.58	0.67	-1.66	-0.78	0.41	0.07	0.02	0.06	-1.1
7	0.05	0.6	0.44	-2.05	-0.08	0.32	-0.24	0.49	0.26	-0.75
8	-0.14	0.4	0.61	-0.62	0.06	-0.11	-0.17	0.03	-0.93	0.26
9	0.46	0.5	-0.53	-0.35	0.4	-0.09	-0.73	-0.22	0.37	-0.63
10	1.16	2.44	0.05	0.66	0.51	0.62	-0.78	0.05	-0.43	-0.01
11	0.47	-0.43	-0.49	0.73	0.85	0.12	-0.44	-0.11	-0.63	0.02

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	0	0	0	-10.635	-10.211	-9.6694	-9.2583	-8.886	-8.886	-8.886
S.E(Log q)	0	0	0	0.9083	0.8618	0.7804	0.4549	0.521	0.917	0.5159

Regression statistics :
Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	5.2	-1.58	2.56	0.02	13	4.4	-10.64

Table 7.7.2.1 (cont.)

6	1.15	-0.271	9.89	0.25	13	1.04	-10.21
7	0.85	0.417	10	0.47	13	0.69	-9.67
8	0.87	0.694	9.55	0.76	13	0.41	-9.26
9	1.29	-1.023	8.22	0.57	13	0.67	-8.89
10	1.41	-0.892	7.57	0.34	13	1.16	-8.49
11	0.86	0.83	9.03	0.79	13	0.45	-8.85

Fleet : FLT10: Jul Pt. Surve

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	99.99	2.19	2.19	-1.22	2.23	-4.73	1.93	-2.01	99.99	0
1	99.99	-0.13	-0.17	-0.18	0.15	-0.18	0.18	0.21	99.99	0.06
2	99.99	-0.5	0.47	-1.01	-0.41	0.94	0.96	-1.52	99.99	0.97
3	99.99	0.41	-0.34	-1.75	-0.18	1.76	0.88	-0.51	99.99	-0.35
4	99.99	1.09	-0.54	-1.62	-0.32	0.46	1.33	0.09	99.99	-0.48
5	99.99	-0.06	-0.05	-1.31	-1.01	1.68	1.35	0.29	99.99	-0.99
6	99.99	-0.18	-0.2	-0.54	-1.17	2.15	1.99	-0.22	99.99	-1.9
7	99.99	-1.18	0.36	0.02	0.14	1.4	1.03	-0.57	99.99	-1.32
8	99.99	0.61	-0.49	1	0.81	2.64	0.27	-2.11	99.99	-2.5
9	99.99	0.7	0.7	-0.43	1.7	1.9	0.98	-2.73	99.99	-2.52
10	99.99	0.72	0.07	1.29	0.2	-0.17	1.32	-1.47	99.99	-2.87
11	99.99	1.11	0.53	1.38	1.85	-2.17	2.06	-1.38	99.99	-1.54

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	-9.1126	-9.5793	-9.9495	-10.0895	-10.1422	-10.2265	-10.4785	-10.2297	-10.2297	-10.2297
S.E(Log q)	0.9992	1.054	0.9552	1.119	1.4492	0.9843	1.7331	1.8339	1.4721	1.7216

Regression statistics :
Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	1.75	-0.307	8.1	0.03	8	2.81	-10.61
1	0.29	3.441	12.29	0.81	8	0.19	-8.52

Table 7.7.2.1 (cont.)

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.93	0.07	9.42	0.15	8	1.01	-9.11
3	0.52	0.984	11.28	0.43	8	0.55	-9.58
4	-1.67	-1.593	17.7	0.06	8	1.44	-9.95
5	-0.9	-2.031	14.63	0.17	8	0.83	-10.09
6	3.16	-0.522	5.67	0.01	8	4.86	-10.14
7	1.2	-0.271	9.87	0.25	8	1.27	-10.23
8	-4.93	-1.403	17.86	0.01	8	7.97	-10.48
9	-5.06	-1.33	16.47	0.01	8	8.78	-10.23
10	2.1	-0.748	9.92	0.08	8	3.17	-10.38
11	-3.35	-2.696	11.14	0.06	8	4.1	-10.04

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 1997

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT06: 8c West trawl	1	0	0	0	0	0	0
FLT07: 8c East trawl	1	0	0	0	0	0	0
FLT08: Oct Pt Survey	1943432	0.421	0	0	1	0.437	0
FLT09: Oct Sp. Surve	1	0	0	0	0	0	0
FLT10: Jul Pt. Surve	1227792	2.997	0	0	1	0.009	0
P shrinkage mean	968904	0.4	0.477	0.008			
F shrinkage mean	423408	1	0.078	0.019			

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1233456	0.28	0.37	4	1.319	0.006

Age 1 Catchability dependent on age and year class strength

Table 7.7.2.1 (cont.)

Year class = 1996

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT06: 8c West trawl	242872	0.742	0	0	1	0.058	0.892
FLT07: 8c East trawl	1	0	0	0	0	0	0
FLT08: Oct Pt Survey	692153	0.349	0.378	1.08	2	0.257	0.409
FLT09: Oct Sp. Surve	1	0	0	0	0	0	0
FLT10: Jul Pt. Surve	712259	0.3	0	0	1	0.355	0.399
P shrinkage mean	633100	0.42	0.281	0.44			
F shrinkage mean	1824551	1	0.049	0.175			

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
672713	0.19	0.17	6	0.897	0.419

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT06: 8c West trawl	55596	0.626	0.961	1.54	2	0.194	1.288
FLT07: 8c East trawl	1	0	0	0	0	0	0
FLT08: Oct Pt Survey	182984	0.357	0.386	1.08	3	0.582	0.587
FLT09: Oct Sp. Surve	1	0	0	0	0	0	0
FLT10: Jul Pt. Surve	360468	1.01	0.859	0.85	2	0.078	0.34
F shrinkage mean	550441	1	0.145	0.235			

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F

Table 7.7.2.1 (cont.)

179635	0.29	0.37	8	1.251	0.596

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT06: 8c West trawl	100074	0.562	0.473	0.84	3	0.139	0.431
FLT07: 8c East trawl	1	0	0	0	0	0	0
FLT08: Oct Pt Survey	105986	0.34	0.316	0.93	4	0.36	0.411
FLT09: Oct Sp. Surve	1	0	0	0	0	0	0
FLT10: Jul Pt. Surve	162064	0.294	0.17	0.58	3	0.417	0.287
F shrinkage mean	325163	1	0.084	0.153			

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
137843	0.21	0.18	11	0.85	0.331

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT06: 8c West trawl	266783	0.502	0.509	1.01	4	0.139	0.115
FLT07: 8c East trawl	1	0	0	0	0	0	0
FLT08: Oct Pt Survey	433482	0.288	0.351	1.22	5	0.415	0.072
FLT09: Oct Sp. Surve	1	0	0	0	0	0	0
FLT10: Jul Pt. Surve	349891	0.28	0.339	1.21	4	0.398	0.089
F shrinkage mean	296241	1	0.047	0.104			

Weighted prediction :

Table 7.7.2.1 (cont.)

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	365420	0.18	0.19	14	1.042	0.085

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT06: 8c West trawl	223851	0.443	0.458	1.04	5	0.161	0.088
FLT07: 8c East trawl	365256	0.626	0	0	1	0.104	0.055
FLT08: Oct Pt Survey	388874	0.281	0.3	1.07	6	0.352	0.052
FLT09: Oct Sp. Surve	253711	0.949	0	0	1	0.045	0.078
FLT10: Jul Pt. Surve	243617	0.281	0.221	0.79	5	0.295	0.081
F shrinkage mean	257275	1	0.043	0.077			

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	296694	0.17	0.15	19	0.874	0.067

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT06: 8c West trawl	190648	0.391	0.461	1.18	6	0.175	0.054
FLT07: 8c East trawl	504888	0.413	0.589	1.43	2	0.184	0.021
FLT08: Oct Pt Survey	327828	0.275	0.231	0.84	7	0.298	0.032
FLT09: Oct Sp. Surve	236929	0.653	0.906	1.39	2	0.073	0.044
FLT10: Jul Pt. Surve	353608	0.279	0.261	0.93	6	0.235	0.029
F shrinkage mean	117051	1	0.033	0.087			

Table 7.7.2.1 (cont.)

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	310077	0.16	0.16	24	1.034	0.034

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT06: 8c West trawl	71487	0.276	0.158	0.57	7	0.28	0.141
FLT07: 8c East trawl	222759	0.329	0.19	0.58	3	0.204	0.048
FLT08: Oct Pt Survey	207783	0.271	0.218	0.8	8	0.215	0.051
FLT09: Oct Sp. Surve	89820	0.511	0.248	0.49	3	0.085	0.114
FLT10: Jul Pt. Surve	127217	0.273	0.319	1.17	7	0.19	0.082
F shrinkage mean	77958	1	0.025	0.13			

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	129306	0.14	0.13	29	0.946	0.081

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1989

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT06: 8c West trawl	80368	0.224	0.102	0.46	8	0.344	0.179
FLT07: 8c East trawl	102864	0.306	0.402	1.31	4	0.184	0.143
FLT08: Oct Pt Survey	124372	0.277	0.25	0.9	9	0.165	0.119
FLT09: Oct Sp. Surve	107471	0.349	0.174	0.5	4	0.149	0.137

Table 7.7.2.1 (cont.)

FLT10: Jul Pt. Surve	83608	0.281	0.271	0.97	8	0.136	0.173
F shrinkage mean	93697	1	0.022	0.156			

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
95224	0.13	0.1	34	0.767	0.153

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1988

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT06: 8c West trawl	55032	0.206	0.158	0.77	9	0.36	0.144
FLT07: 8c East trawl	91489	0.27	0.172	0.64	5	0.206	0.089
FLT08: Oct Pt Survey	41618	0.287	0.263	0.92	10	0.125	0.187
FLT09: Oct Sp. Surve	30754	0.297	0.248	0.84	5	0.183	0.245
FLT10: Jul Pt. Surve	44243	0.291	0.368	1.26	8	0.104	0.177
F shrinkage mean	29312	1	0.021	0.256			

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
51171	0.12	0.11	38	0.927	0.154

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1987

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT06: 8c West trawl	82257	0.19	0.066	0.35	10	0.399	0.2
FLT07: 8c East trawl	90054	0.261	0.299	1.14	6	0.204	0.185

Table 7.7.2.1 (cont.)

FLT08: Oct Pt Survey	40398	0.282	0.261	0.92	11	0.136	0.373
FLT09: Oct Sp. Surve	74231	0.284	0.181	0.64	6	0.181	0.22
FLT10: Jul Pt. Surve	37881	0.461	0.566	1.23	8	0.057	0.393
F shrinkage mean	66480	1	0.024	0.243			

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
71113	0.12	0.1	42	0.878	0.229

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1986

Fleet	Es Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT06: 8c West trawl	68637	0.187	0.093	0.5	11	0.397	0.167
FLT07: 8c East trawl	66026	0.26	0.171	0.66	7	0.192	0.173
FLT08: Oct Pt Survey	18878	0.31	0.256	0.83	12	0.114	0.507
FLT09: Oct Sp. Surve	42319	0.258	0.143	0.55	7	0.229	0.258
FLT10: Jul Pt. Surve	32959	0.507	0.48	0.95	8	0.044	0.321
F shrinkage mean	89444	1	0.025	0.13			

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
51334	0.12	0.1	46	0.834	0.217

Table 7.7.2.2 Terminal Fs derived using XSA (With F shrinkage)

Table 8	Fishing mortality (F) at age		
YEAR	1985	1986	1987
AGE			
0			
1	0.2887	0.2862	0.04
2	0.4374	0.5454	0.4893
3	0.2174	0.233	0.4103
4	0.0499	0.2422	0.2337
5	0.1178	0.0957	0.1527
6	0.0879	0.1659	0.0803
7	0.0681	0.1043	0.1814
8	0.1465	0.3309	0.1035
9	0.1036	0.3579	0.0991
10	0.1463	0.2399	0.1708
11	0.1736	0.2735	0.1165
+gp	0.3002	0.3612	0.0933
0 FBAR 1	0.3002	0.3612	0.0933
FBAR 0-	0.1681	0.2682	0.1938
FBAR 7-	0.2484	0.3267	0.2933
	0.1741	0.3127	0.1167

Table 8	Fishing mortality (F) at age										
YEAR											
AGE	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	FBAR 95-97
0											
1											
2	0.1407	0.2352	0.0514	0.0172	0.0312	0.0093	0.0159	0.0068	0.0295	0.0064	0.0143
3	0.2758	0.2591	0.2339	0.0928	0.2	0.0852	0.1222	0.3833	0.0835	0.4189	0.2952
4	0.1194	0.1008	0.2465	0.1429	0.1924	0.2704	0.3145	0.1818	0.2135	0.5961	0.3305
5	0.1467	0.157	0.1114	0.0812	0.1391	0.2455	0.137	0.1642	0.0795	0.3307	0.1915
6	0.1101	0.1915	0.0788	0.08	0.0917	0.1266	0.0836	0.0909	0.1252	0.0852	0.1005
7	0.1468	0.1654	0.0986	0.0791	0.069	0.1275	0.0513	0.0711	0.0671	0.0674	0.0685
8	0.1181	0.229	0.1017	0.1249	0.087	0.0827	0.1358	0.0624	0.064	0.0335	0.0533
9	0.2012	0.0861	0.1852	0.167	0.1707	0.1614	0.1077	0.1318	0.0787	0.0808	0.0971
10	0.1521	0.1865	0.1652	0.2468	0.1802	0.2002	0.1666	0.1231	0.1063	0.1535	0.1276
11	0.2835	0.2791	0.2224	0.193	0.4157	0.3626	0.1958	0.1425	0.1573	0.1545	0.1514
+gp	0.5136	0.5349	0.1801	0.3068	0.2235	0.3265	0.1899	0.3036	0.1651	0.2285	0.2324
0 FBAR 1	0.3256	0.3597	0.2954	0.2208	0.2755	0.2242	0.2188	0.3115	0.362	0.2174	0.297
FBAR 0-	0.3256	0.3597	0.2954	0.2208	0.2755	0.2242	0.2188	0.3115	0.362	0.2174	
FBAR 7-	0.2175	0.2317	0.1745	0.1577	0.1859	0.2012	0.1567	0.1787	0.1366	0.2151	
1	0.1706	0.188	0.1608	0.0835	0.1407	0.1526	0.1474	0.184	0.1015	0.338	
	0.2952	0.2893	0.2097	0.2269	0.2531	0.255	0.1758	0.2025	0.1739	0.1669	

Table 7.7.2.3 Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3
YEAR

AGE	1985	1986	1987
0			
1			
2	1692388	2665050	1465914
3	905050	1091402	1722991
4	468248	502994	544475
5	1767404	324271	342940
6	254152	1447140	219077
7	187946	194446	1131860
8	115841	148161	141771
9	58223	93142	114897
10	43588	43282	57581
11	49660	33823	26046
+gp	31201	36926	22901
0 TOT/	13357	22574	24177
	39707	49748	67007
	5626764	6652959	5881640

Table 10 Stock number at age (start of year) Numbers*10**-3
YEAR

AGE	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	GMST 85-95
0												
1												
2	1001729	1247574	1034932	2004523	1603389	1245097	644037	558288	1420348	1440488	0	1256310
3	1212256	749057	848785	846150	1695821	1337718	1061721	545575	477264	1186931	1233456	1034904
4	909119	791932	497536	578216	663769	1195016	1057381	808676	320082	377894	672713	694098
5	310904	694401	616274	334686	431386	471337	784900	664481	580316	222527	179635	530064
6	233659	231078	510849	474499	265596	323082	317379	589092	485320	461299	137843	368311
7	161853	180147	164227	406357	377017	208565	245008	251253	462961	368547	365420	261414
8	899036	120283	131421	128079	323149	302877	158028	200328	201415	372616	296694	192851
9	101775	687622	82339	102181	97294	254968	239990	118748	162001	162616	310077	134443
10	89165	71630	542990	58890	74423	70599	186743	185465	89583	128880	129306	92085
11	44883	65919	51162	396186	39603	53495	49742	136065	141140	69327	95224	60198
+gp	18897	29095	42922	35256	281160	22493	32040	35200	101561	103797	51171	36573
0 TOT/	17543	9732	14668	30855	22329	193521	13967	22807	22364	74111	71113	22573
1	52719	41712	47916	55184	55179	30255	75253	87114	83674	78353	105595	
	5053539	4920184	4586024	5451063	5930116	5709026	4866188	4203094	4548031	5047384	3648247	

Table 7.7.2.4 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

1985	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 1-11	FBAR 0- 3	FBAR 7-11
1986	Age 0							
1987	1692387	313665	136355	43530	0.3192	0.1681	0.2484	0.1741
1988	2665051	354009	193584	71490	0.3693	0.2682	0.3267	0.3127
1989	1465914	375219	218472	54650	0.2501	0.1938	0.2933	0.1167
1990	1001729	371881	221428	56390	0.2547	0.2175	0.1706	0.2952
1991	1247575	362922	219030	56396	0.2575	0.2317	0.188	0.2893
1992	1034932	370924	234617	49207	0.2097	0.1745	0.1608	0.2097
1993	2004524	368648	239867	45511	0.1897	0.1577	0.0835	0.2269
1994	1603390	392874	233861	50956	0.2179	0.1859	0.1407	0.2531
1995	1245097	399280	223097	57428	0.2574	0.2012	0.1526	0.255
1996	644038	371351	199315	52588	0.2638	0.1567	0.1474	0.1758
1997	558288	375989	226997	52681	0.2321	0.1787	0.184	0.2025
	1420348	361961	243635	44690	0.1834	0.1366	0.1015	0.1739
Arith. Mean	1440488	379213	255367	56770	0.2223	0.2151	0.338	0.1669
0 Units	1386443	369072	218894	53253	0.2483	0.1912	0	0.2194
1	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)				

Table 7.8.1 Input data for the predictions

15:42 Thursday, October 1, 1998

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Input data

Year: 1998								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	1362.450	0.1500	0.0000	0.2500	0.2500	0.000	0.0143	0.022
1	1233.456	0.1500	0.0000	0.2500	0.2500	0.032	0.2952	0.033
2	672.413	0.1500	0.0400	0.2500	0.2500	0.055	0.3305	0.054
3	179.635	0.1500	0.2700	0.2500	0.2500	0.075	0.1915	0.091
4	137.843	0.1500	0.6300	0.2500	0.2500	0.105	0.1005	0.123
5	365.420	0.1500	0.8100	0.2500	0.2500	0.127	0.0685	0.149
6	296.694	0.1500	0.9000	0.2500	0.2500	0.154	0.0533	0.171
7	310.077	0.1500	0.9500	0.2500	0.2500	0.176	0.0971	0.202
8	129.306	0.1500	0.9700	0.2500	0.2500	0.213	0.1276	0.209
9	95.224	0.1500	0.9800	0.2500	0.2500	0.240	0.1514	0.246
10	51.171	0.1500	0.9900	0.2500	0.2500	0.269	0.2324	0.233
11	71.113	0.1500	1.0000	0.2500	0.2500	0.304	0.2970	0.265
12+	105.595	0.1500	1.0000	0.2500	0.2500	0.318	0.2970	0.313
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1999								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	1362.450	0.1500	0.0000	0.2500	0.2500	0.000	0.0143	0.022
1	.	0.1500	0.0000	0.2500	0.2500	0.032	0.2952	0.033
2	.	0.1500	0.0400	0.2500	0.2500	0.055	0.3305	0.054
3	.	0.1500	0.2700	0.2500	0.2500	0.075	0.1915	0.091
4	.	0.1500	0.6300	0.2500	0.2500	0.105	0.1005	0.123
5	.	0.1500	0.8100	0.2500	0.2500	0.127	0.0685	0.149
6	.	0.1500	0.9000	0.2500	0.2500	0.154	0.0533	0.171
7	.	0.1500	0.9500	0.2500	0.2500	0.176	0.0971	0.202
8	.	0.1500	0.9700	0.2500	0.2500	0.213	0.1276	0.209
9	.	0.1500	0.9800	0.2500	0.2500	0.240	0.1514	0.246
10	.	0.1500	0.9900	0.2500	0.2500	0.269	0.2324	0.233
11	.	0.1500	1.0000	0.2500	0.2500	0.304	0.2970	0.265
12+	.	0.1500	1.0000	0.2500	0.2500	0.318	0.2970	0.313
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2000								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	1362.450	0.1500	0.0000	0.2500	0.2500	0.000	0.0143	0.022
1	.	0.1500	0.0000	0.2500	0.2500	0.032	0.2952	0.033
2	.	0.1500	0.0400	0.2500	0.2500	0.055	0.3305	0.054
3	.	0.1500	0.2700	0.2500	0.2500	0.075	0.1915	0.091
4	.	0.1500	0.6300	0.2500	0.2500	0.105	0.1005	0.123
5	.	0.1500	0.8100	0.2500	0.2500	0.127	0.0685	0.149
6	.	0.1500	0.9000	0.2500	0.2500	0.154	0.0533	0.171
7	.	0.1500	0.9500	0.2500	0.2500	0.176	0.0971	0.202
8	.	0.1500	0.9700	0.2500	0.2500	0.213	0.1276	0.209
9	.	0.1500	0.9800	0.2500	0.2500	0.240	0.1514	0.246
10	.	0.1500	0.9900	0.2500	0.2500	0.269	0.2324	0.233
11	.	0.1500	1.0000	0.2500	0.2500	0.304	0.2970	0.265
12+	.	0.1500	1.0000	0.2500	0.2500	0.318	0.2970	0.313
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : SPRPA802
Date and time: 01OCT98:17:05

Table 7.8.2.a Prediction with managent option table

Southern horse mackerel (Divisions VIIIc and IXa) 15:42 Thursday, October 1, 1998

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.1768	703275	255881	55771	0.0000	0.0000	758302	255120	0	922057	288158
.	.	.	.	.	0.1000	0.0177	.	254084	6456	900228	282140
.	.	.	.	.	0.2000	0.0354	.	253054	12767	878994	276282
.	.	.	.	.	0.3000	0.0530	.	252029	18937	858340	270578
.	.	.	.	.	0.4000	0.0707	.	251010	24970	838247	265024
.	.	.	.	.	0.5000	0.0884	.	249997	30870	818700	259614
.	.	.	.	.	0.6000	0.1061	.	248989	36639	799685	254346
.	.	.	.	.	0.7000	0.1238	.	247986	42281	781184	249214
.	.	.	.	.	0.8000	0.1415	.	246989	47799	763185	244214
.	.	.	.	.	0.9000	0.1591	.	245997	53198	745672	239343
.	.	.	.	.	1.0000	0.1768	.	245010	58479	728632	234596
.	.	.	.	.	1.1000	0.1945	.	244028	63646	712052	229970
.	.	.	.	.	1.2000	0.2122	.	243052	68701	695918	225461
.	.	.	.	.	1.3000	0.2299	.	242081	73648	680218	221065
.	.	.	.	.	1.4000	0.2475	.	241115	78490	664940	216780
.	.	.	.	.	1.5000	0.2652	.	240154	83228	650071	212602
.	.	.	.	.	1.6000	0.2829	.	239198	87866	635600	208527
.	.	.	.	.	1.7000	0.3006	.	238248	92407	621516	204553
.	.	.	.	.	1.8000	0.3183	.	237302	96852	607807	200677
.	.	.	.	.	1.9000	0.3360	.	236362	101204	594464	196896
.	.	.	.	.	2.0000	0.3536	.	235426	105465	581476	193208
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANPA803
Date and time : 01OCT98:17:18
Computation of ref. F: Simple mean, age 1 - 11
Basis for 1998 : F factors

Table 7.8.2b

The SAS System 12:10 Tuesday, October 6, 1998

Southern horse mackerel (Divisions VIIIc and IXa)

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0046	0.1776	703275	255836	56000	0.0000	0.0000	757512	254946	0	921751	287970
.	.	.	.	.	0.1000	0.0177	.	253911	6450	899929	281957
.	.	.	.	.	0.2000	0.0354	.	252882	12756	878702	276103
.	.	.	.	.	0.3000	0.0530	.	251858	18921	858054	270403
.	.	.	.	.	0.4000	0.0707	.	250840	24949	837968	264853
.	.	.	.	.	0.5000	0.0884	.	249828	30844	818428	259448
.	.	.	.	.	0.6000	0.1061	.	248821	36608	799418	254184
.	.	.	.	.	0.7000	0.1238	.	247819	42245	780924	249056
.	.	.	.	.	0.8000	0.1415	.	246822	47759	762930	244060
.	.	.	.	.	0.9000	0.1591	.	245831	53153	745423	239192
.	.	.	.	.	1.0000	0.1768	.	244845	58430	728389	234449
.	.	.	.	.	1.1000	0.1945	.	243865	63593	711814	229826
.	.	.	.	.	1.2000	0.2122	.	242889	68644	695685	225320
.	.	.	.	.	1.3000	0.2299	.	241919	73587	679990	220928
.	.	.	.	.	1.4000	0.2475	.	240954	78424	664717	216646
.	.	.	.	.	1.5000	0.2652	.	239994	83159	649853	212471
.	.	.	.	.	1.6000	0.2829	.	239039	87793	635387	208399
.	.	.	.	.	1.7000	0.3006	.	238089	92330	621307	204428
.	.	.	.	.	1.8000	0.3183	.	237144	96771	607603	200555
.	.	.	.	.	1.9000	0.3360	.	236205	101120	594265	196777
.	.	.	.	.	2.0000	0.3536	.	235270	105378	581281	193091
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANPA803
Date and time : 06OCT98:12:11
Computation of ref. F: Simple mean, age 1 - 11
Basis for 1998 : TAC constraints

Table 7.8.2c

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Detailed tables

Year: 1998 F-factor: 1.0000 Reference F: 0.1768

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0	0.0143	17967	395	1362450	0	0	0	0	0
1	0.2952	293864	9698	1233456	39471	0	0	0	0
2	0.3305	176457	9529	672413	36983	26897	1479	23852	1312
3	0.1915	29142	2652	179635	13473	48501	3638	44532	3340
4	0.1005	12254	1507	137843	14474	86841	9118	81569	8565
5	0.0685	22485	3350	365420	46408	295990	37591	280255	35592
6	0.0533	14310	2447	296694	45691	267025	41122	253792	39084
7	0.0971	26677	5389	310077	54574	294573	51845	276927	48739
8	0.1276	14407	3011	129306	27542	125427	26716	117017	24925
9	0.1514	12447	3062	95224	22854	93320	22397	86546	20771
10	0.2324	9882	2303	51171	13765	50659	13627	46041	12385
11	0.2970	17031	4513	71113	21618	71113	21618	63594	19333
12+	0.2970	25290	7916	105595	33579	105595	33579	94430	30029
Total		672214	55771	5010397	370431	1465941	262730	1368557	244074
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1999 F-factor: 1.0000 Reference F: 0.1768

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0	0.0143	17967	395	1362450	0	0	0	0	0
1	0.2952	275416	9089	1156022	36993	0	0	0	0
2	0.3305	207385	11199	790270	43465	31611	1739	28033	1542
3	0.1915	67465	6139	415870	31190	112285	8421	103096	7732
4	0.1005	11350	1396	127667	13405	80430	8445	75548	7933
5	0.0685	6602	984	107299	13627	86912	11038	82292	10451
6	0.0533	14165	2422	293697	45229	264327	40706	251228	38689
7	0.0971	20830	4208	242112	42612	230007	40481	216228	38056
8	0.1276	26985	5640	242190	51586	234924	50039	219173	46684
9	0.1514	12805	3150	97962	23511	96003	23041	89035	21368
10	0.2324	13605	3170	70445	18950	69741	18760	63382	17050
11	0.2970	8361	2216	34910	10613	34910	10613	31219	9491
12+	0.2970	27066	8472	113013	35938	113013	35938	101063	32138
Total		710002	58479	5053906	367118	1354161	249221	1260297	231134
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2000 F-factor: 1.0000 Reference F: 0.1768

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
0	0.0143	17967	395	1362450	0	0	0	0	0
1	0.2952	275416	9089	1156022	36993	0	0	0	0
2	0.3305	194366	10496	740659	40736	29626	1629	26273	1445
3	0.1915	79290	7215	488762	36657	131966	9897	121167	9087
4	0.1005	26276	3232	295560	31034	186203	19551	174900	18364
5	0.0685	6115	911	99378	12621	80496	10223	76217	9680
6	0.0533	4159	711	86238	13281	77615	11953	73768	11360
7	0.0971	20619	4165	239666	42181	227683	40072	214043	37672
8	0.1276	21070	4404	189105	40279	183432	39071	171133	36451
9	0.1514	23984	5900	183483	44036	179813	43155	166762	40023
10	0.2324	13996	3261	72471	19495	71746	19300	65205	17540
11	0.2970	11510	3050	48059	14610	48059	14610	42978	13065
12+	0.2970	22657	7092	94603	30084	94603	30084	84600	26903
Total		717425	59921	5056455	362006	1311241	239545	1217046	221591
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 7.9.1 Codes used in the output of the short-term forecast sensitivity analysis.

N1	Population at age 1
sH1	Exploitation pattern of age 1
WH1	Catch weight at age 1
WS1	Stock weight at age 1
M1	Natural mortality at age 1
MT1	Maturity at age 1
HF99	Effort multiplier in 1999
K98	Natural mortality multiplier in 1998
R99	Recruitment in 1999

(Numbers in these codes represent age class or year)

Table 7.9.2 Parameter values and CV's used as input for the sensitivity analysis.

Parameter	Value	CV	Parameter	Value	CV	Parameter	Value	CV	Parameter	Value	CV
N0	1361478	0.4	**WH0**	0.021	0.38	**M0**	0.15	0.1	**R99**	1361478	0.4
N1	1232646	0.37	**WH1**	0.033	0.11	**M1**	0.15	0.1	**R****	1361478	0.4
N2	671413	0.19	**WH2**	0.059	0.1	**M2**	0.15	0.1	**HF98**	1	0.22
N3	179489	0.37	**WH3**	0.095	0.08	**M3**	0.15	0.1	**HF99**	1	0.22
N4	137001	0.21	**WH4**	0.121	0.08	**M4**	0.15	0.1	**HF****	1	0.22
N5	365441	0.19	**WH5**	0.147	0.05	**M5**	0.15	0.1	**K98**	1	0.1
N6	295305	0.17	**WH6**	0.175	0.03	**M6**	0.15	0.1	**K99**	1	0.1
N7	309137	0.16	**WH7**	0.199	0.04	**M7**	0.15	0.1	**K****	1	0.1
N8	129195	0.14	**WH8**	0.213	0.02	**M8**	0.15	0.1			
N9	95366	0.13	**WH9**	0.236	0.04	**M9**	0.15	0.1			
N10	51150	0.12	**WH10**	0.254	0.08	**M10**	0.15	0.1			
N11	71003	0.12	**WH11**	0.278	0.05	**M11**	0.15	0.1			
N12	105142	0.12	**WH12**	0.326	0.04	**M12**	0.15	0.1			
sH0	0.014	1.11	**WS0**	0	0	**MT0**	0	0			
sH1	0.296	0.53	**WS1**	0.032	0	**MT1**	0	0.1			
sH2	0.331	0.5	**WS2**	0.055	0	**MT2**	0.04	0.1			
sH3	0.192	0.48	**WS3**	0.075	0	**MT3**	0.27	0.1			
sH4	0.101	0.45	**WS4**	0.105	0	**MT4**	0.63	0.1			
sH5	0.069	0.22	**WS5**	0.127	0	**MT5**	0.81	0.1			
sH6	0.053	0.49	**WS6**	0.154	0	**MT6**	0.9	0.1			
sH7	0.097	0.32	**WS7**	0.176	0	**MT7**	0.95	0.1			
sH8	0.128	0.06	**WS8**	0.213	0	**MT8**	0.97	0.1			
sH9	0.152	0.26	**WS9**	0.24	0	**MT9**	0.98	0.1			
sH10	0.233	0.25	**WS10**	0.269	0	**MT10**	0.99	0.1			
sH11	0.299	0.46	**WS11**	0.304	0	**MT11**	1	0.1			
sH12	0.299	0.46	**WS12**	0.351	0.02	**MT12**	1	0			

Table 7.11.1 Yield per recruit summary table

15:42 Thursday, October 1, 1998

Southern horse mackerel (Divisions VIIIc and IXa)

Yield per recruit: Summary table

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0.000	7.179	980.077	3.774	832.679	3.635	802.032
0.1000	0.0177	0.106	15.397	6.473	807.741	3.151	667.798	3.022	639.932
0.2000	0.0354	0.189	25.024	5.925	681.699	2.682	548.673	2.562	523.324
0.3000	0.0530	0.255	31.217	5.483	585.241	2.313	458.641	2.202	435.569
0.4000	0.0707	0.311	35.252	5.115	508.966	2.015	388.339	1.911	367.329
0.5000	0.0884	0.358	37.876	4.803	447.154	1.767	332.082	1.671	312.940
0.6000	0.1061	0.398	39.550	4.534	396.108	1.559	286.206	1.469	268.757
0.7000	0.1238	0.434	40.572	4.300	353.322	1.382	248.234	1.298	232.320
0.8000	0.1415	0.465	41.138	4.093	317.027	1.229	216.426	1.151	201.904
0.9000	0.1591	0.493	41.383	3.910	285.936	1.097	189.521	1.024	176.263
1.0000	0.1768	0.518	41.400	3.747	259.088	0.981	166.579	0.914	154.468
1.1000	0.1945	0.540	41.256	3.600	235.744	0.880	146.884	0.817	135.814
1.2000	0.2122	0.560	40.998	3.468	215.329	0.791	129.878	0.732	119.756
1.3000	0.2299	0.578	40.660	3.349	197.385	0.711	115.124	0.657	105.862
1.4000	0.2475	0.595	40.268	3.241	181.544	0.641	102.268	0.590	93.788
1.5000	0.2652	0.610	39.840	3.143	167.505	0.579	91.025	0.531	83.258
1.6000	0.2829	0.623	39.391	3.053	155.021	0.523	81.161	0.479	74.042
1.7000	0.3006	0.636	38.930	2.971	143.884	0.474	72.483	0.432	65.954
1.8000	0.3183	0.648	38.465	2.896	133.921	0.429	64.827	0.390	58.836
1.9000	0.3360	0.658	38.003	2.827	124.986	0.389	58.059	0.353	52.559
2.0000	0.3536	0.668	37.546	2.764	116.952	0.353	52.064	0.319	47.010
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDPAB02
Date and time : 01OCT98:17:33
Computation of ref. F: Simple mean, age 1 - 11
F-0.1 factor : 0.5148
F-max factor : 0.9577
F-0.1 reference F : 0.0910
F-max reference F : 0.1693
Recruitment : Single recruit

Table 7.14.1

The SAS System 11:28 Sunday, October 4, 1998

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Summary table

F *status quo*

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.0000	0.1768	672214	55771	5010397	370431	1465941	262730	1368557	244074
1999	1.0000	0.1768	710002	58479	5053906	367118	1354161	249221	1260297	231134
2000	1.0000	0.1768	717425	59921	5056455	362006	1311241	239545	1217046	221591
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRPAB02
Date and time : 04OCT98:11:30
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

The SAS System 09:47 Friday, October 2, 1998

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Summary table

F pa (= **F** max)

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	0.9577	0.1693	647088	53651	5010397	370431	1465941	262730	1370355	244445
1999	0.9577	0.1693	687935	56696	5077038	369541	1362158	250697	1269496	232857
2000	0.9577	0.1693	697257	58410	5096665	366605	1328932	242564	1235317	224747
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRPAB02
Date and time : 02OCT98:16:06
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

The SAS System 09:47 Friday, October 2, 1998

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Summary table

F med

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	0.9338	0.1651	632774	52445	5010397	370431	1465941	262730	1371372	244655
1999	0.9338	0.1651	675211	55667	5090219	370920	1366707	251536	1274735	233839
2000	0.9338	0.1651	685557	57526	5119719	369241	1339069	244292	1245798	226556
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRPAB02
Date and time : 02OCT98:16:06
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

Table 7.14.1 (cont.)

Single option prediction: Summary table

F corresponding to constant TAC

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January		Spawning time	
							Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.0046	0.1776	674920	56000	5010397	370431	1465941	262730	1368362	244034
1999	0.9537	0.1686	680469	56000	5051415	366857	1353299	249062	1261497	231391
2000	0.9192	0.1625	670507	56000	5081501	364572	1319787	241062	1228573	223707
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRPAB02
Date and time : 04OCT98:11:30
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : TAC constraints

Single option prediction: Summary table

F corresponding to TAC 1997

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January		Spawning time	
							Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.0046	0.1776	674930	56001	5010397	370431	1465941	262730	1368361	244034
1999	1.0046	0.1776	712367	58670	5051406	366856	1353296	249061	1259303	230947
2000	1.0046	0.1776	719577	60081	5052127	361511	1309336	239220	1215080	221251
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRPAB02
Date and time : 04OCT98:11:30
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

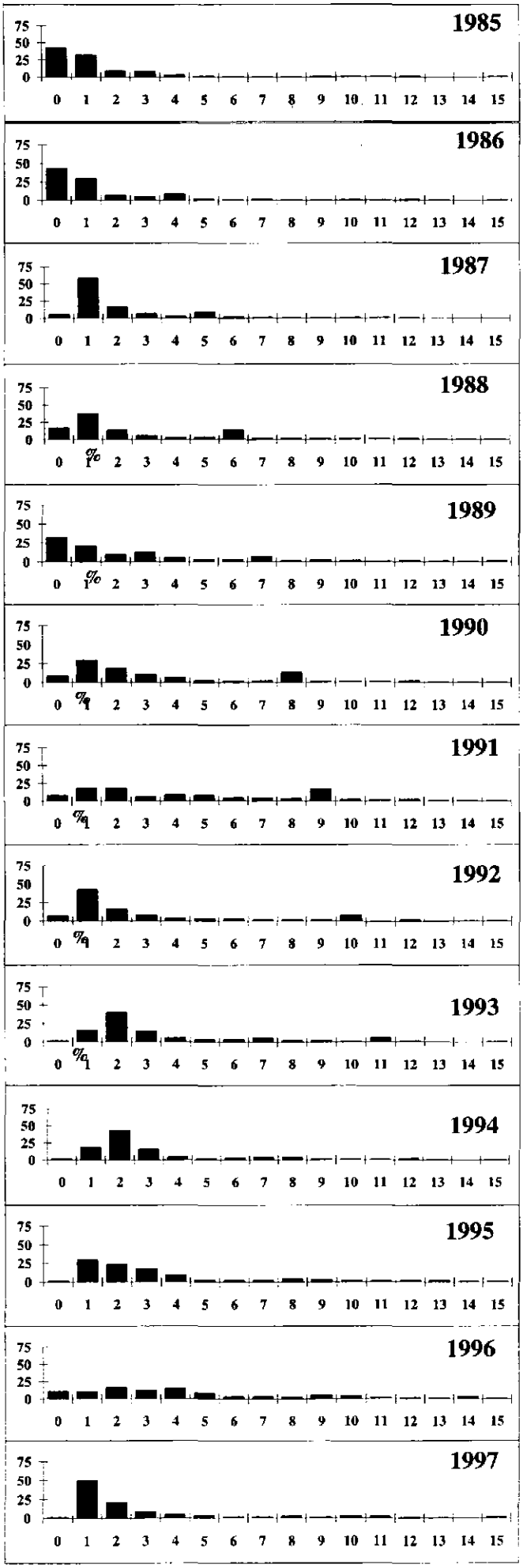


Figure 7.3.1.1.- The age composition of southern horse mackerel in the international catches from 1985-1997. Age 15 is a plus group.

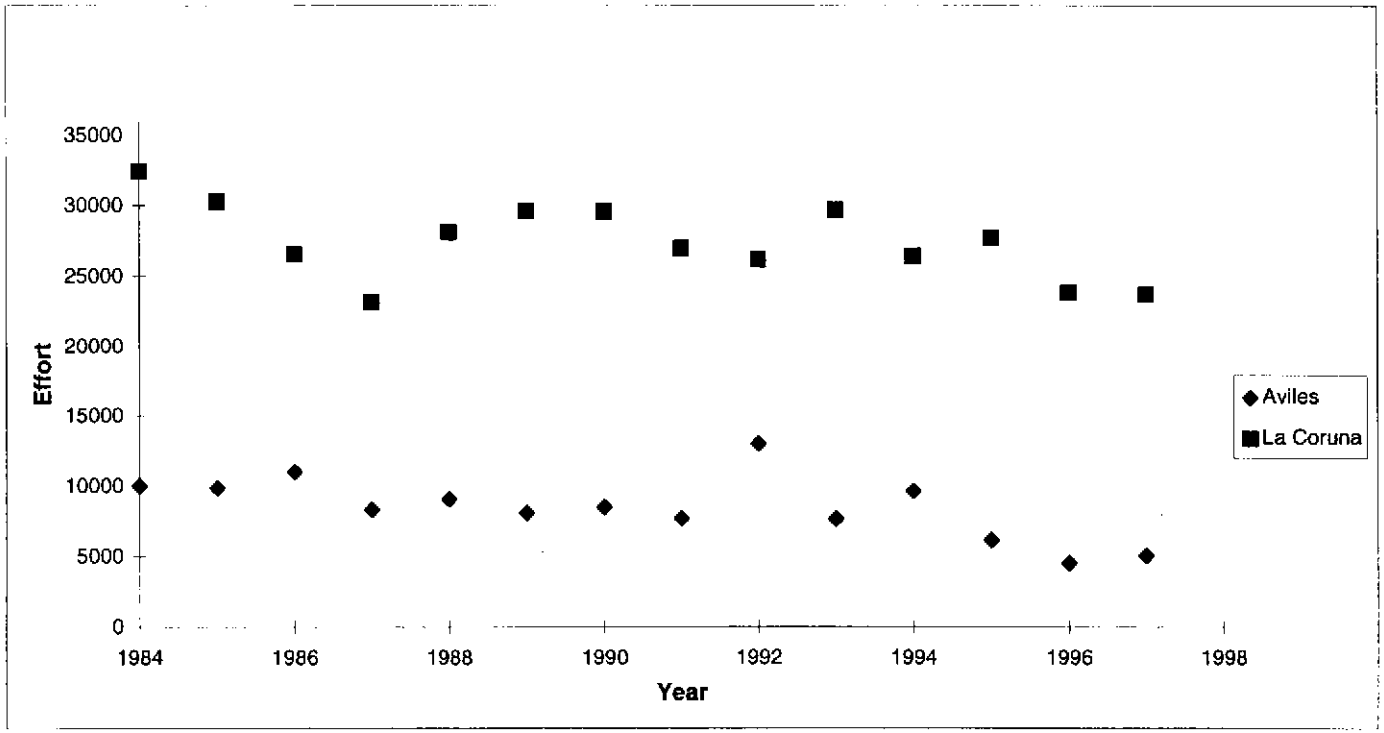


Figure 7.5.1 Effort series from Spanish commercial bottom trawl fleets

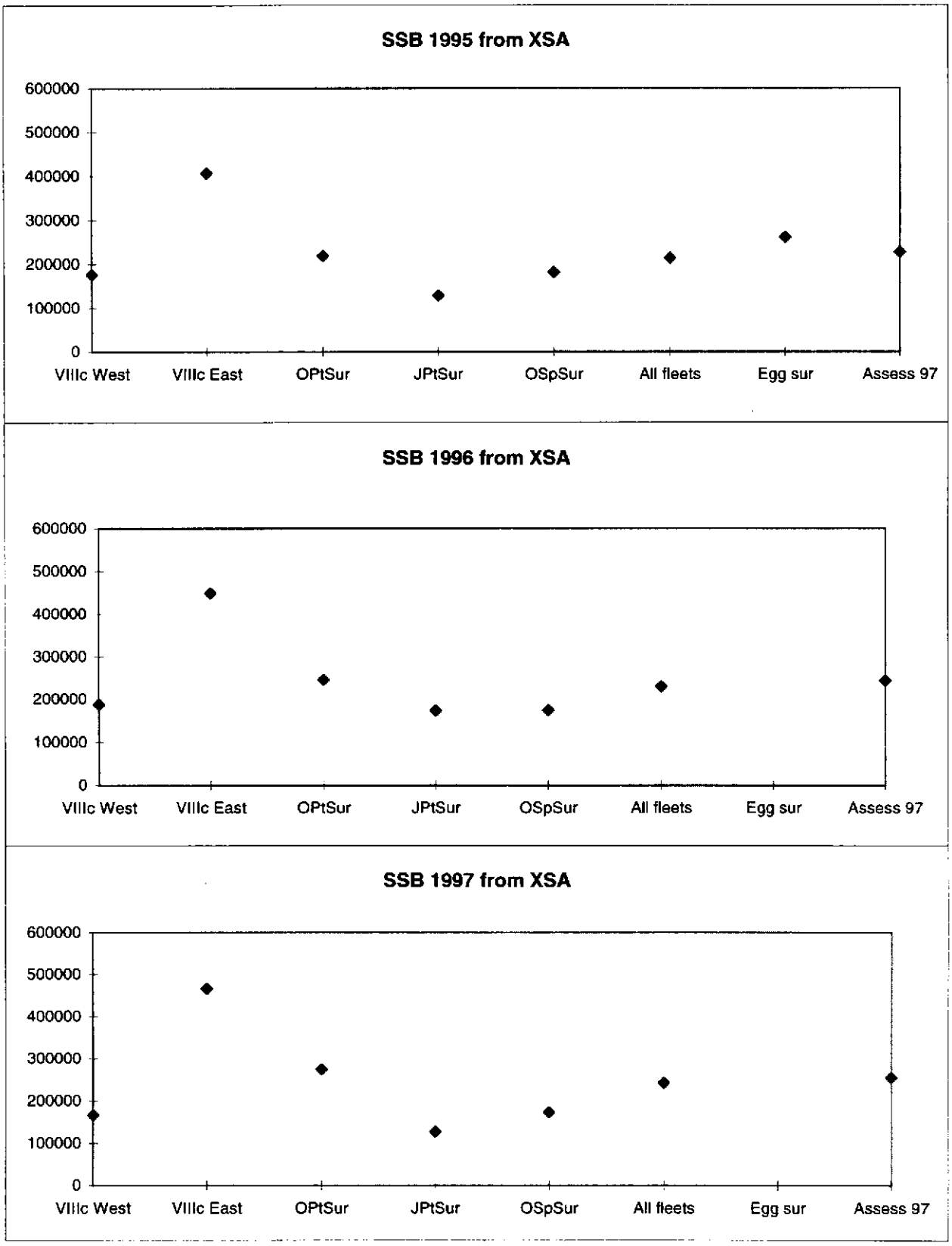


Figure 7.7.1.1 SSB estimates in 1995, 1996 and 1997 by source of independent information.

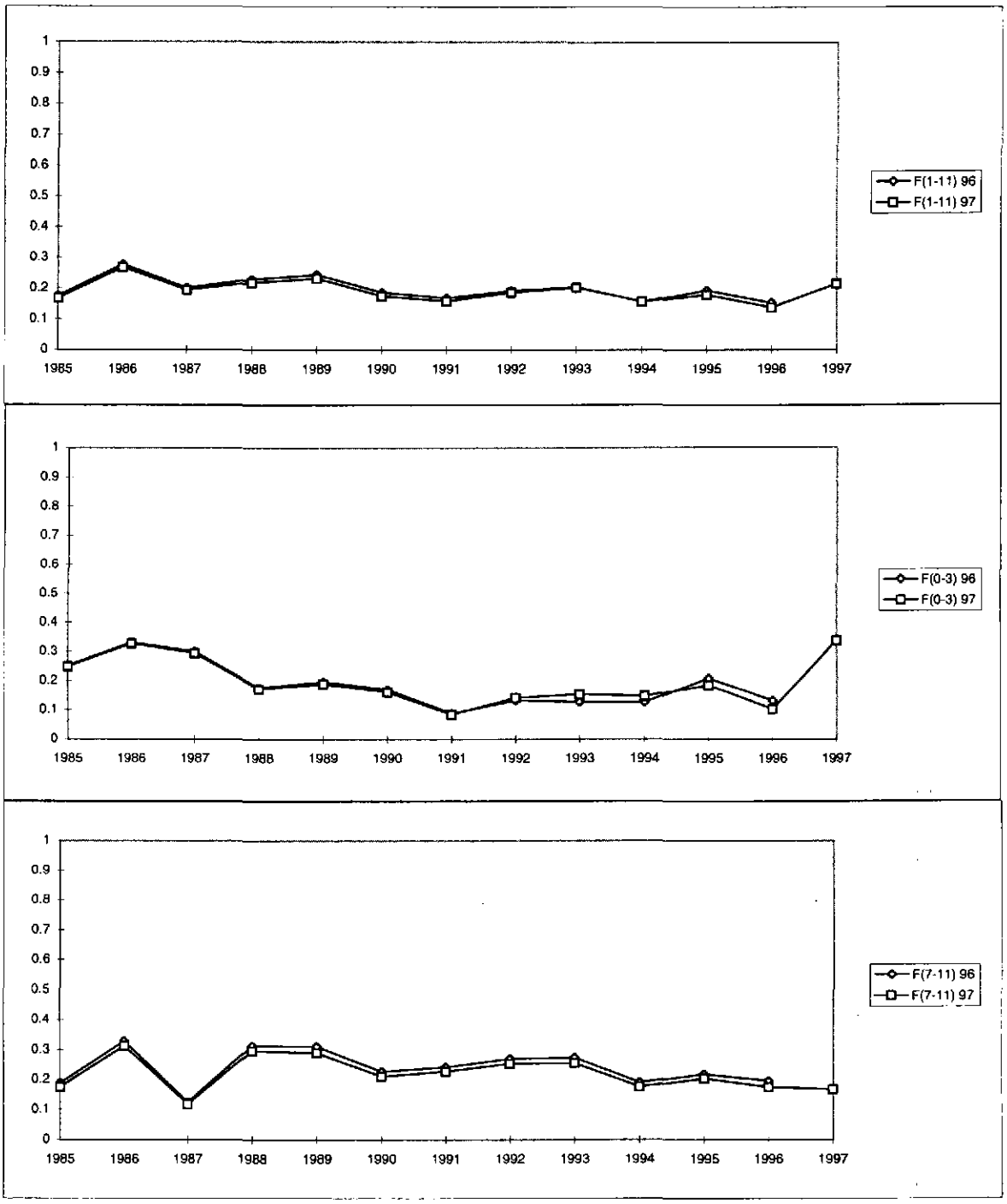


Figure 7.7.2.1 Comparison of the 1996 and 1997 assessments for different F's bar from the final VPA.

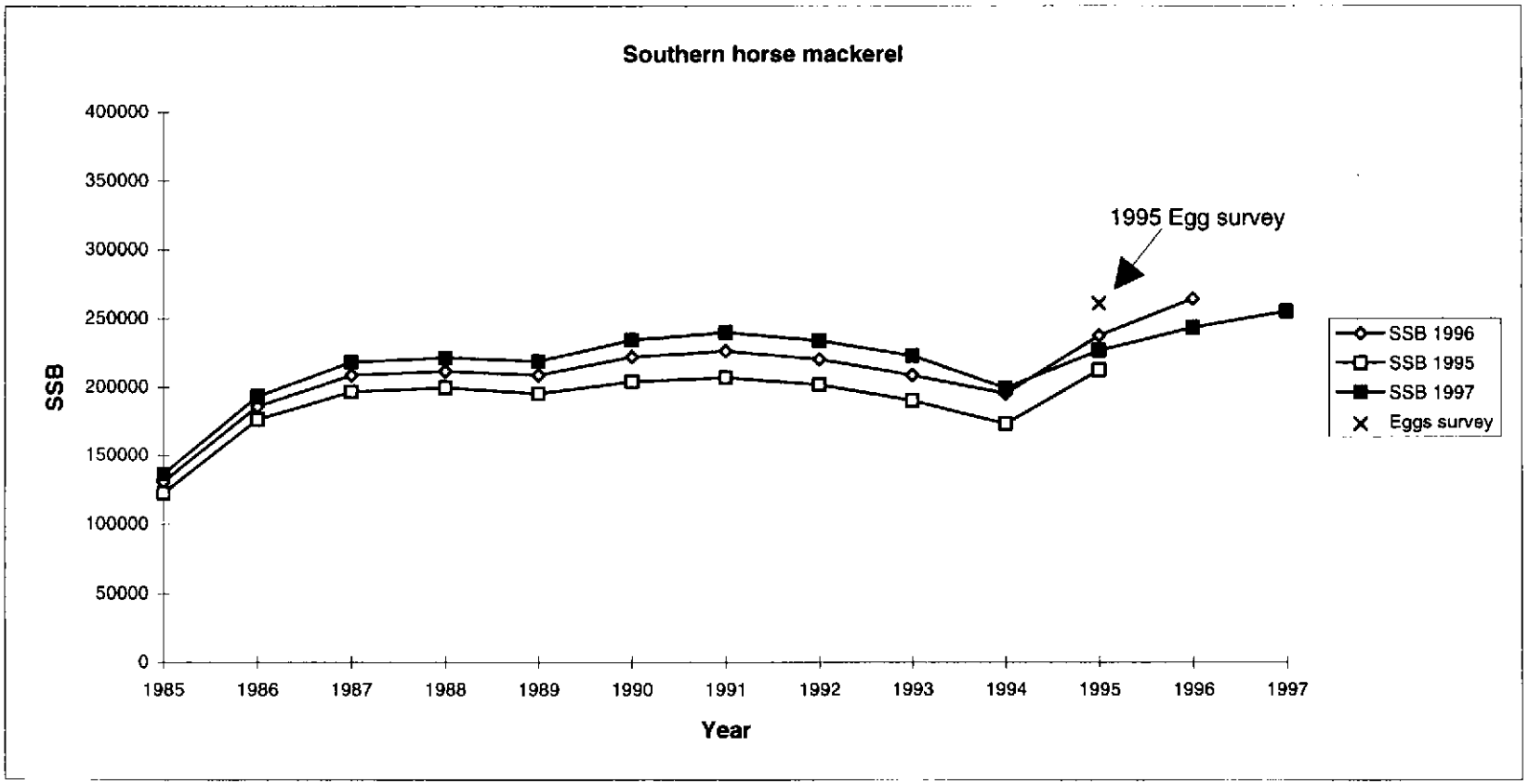


Figure 7.7.2.2 Comparison of the SSB estimates from the 1995 - 1997 analytical assessments and the 1995 egg survey.

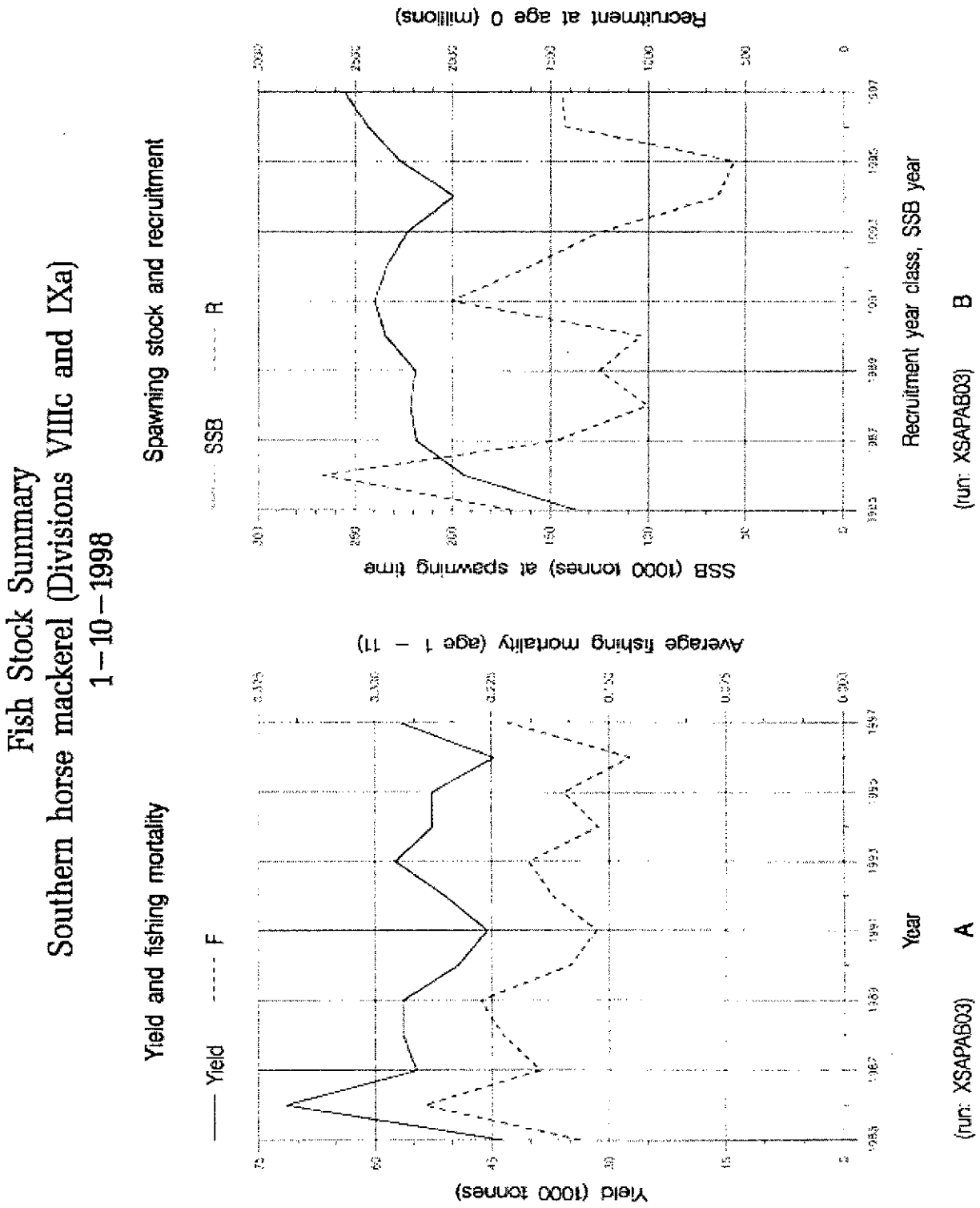


Figure 7.7.2.3 Fish stock summary for the Southern Horse Mackerel.

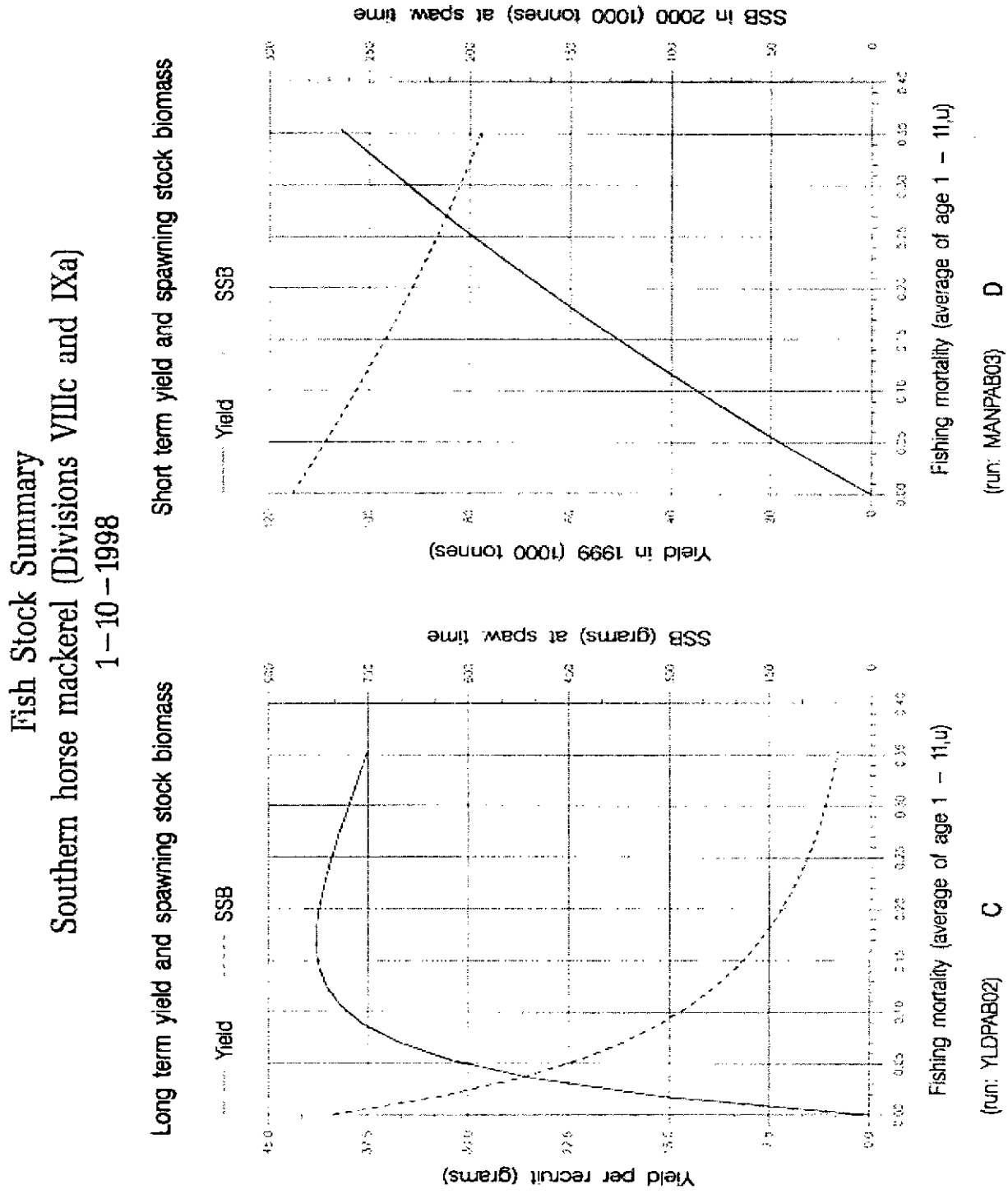


Figure 7.8.1 Long and short-term yield for the Southern Horse Mackerel

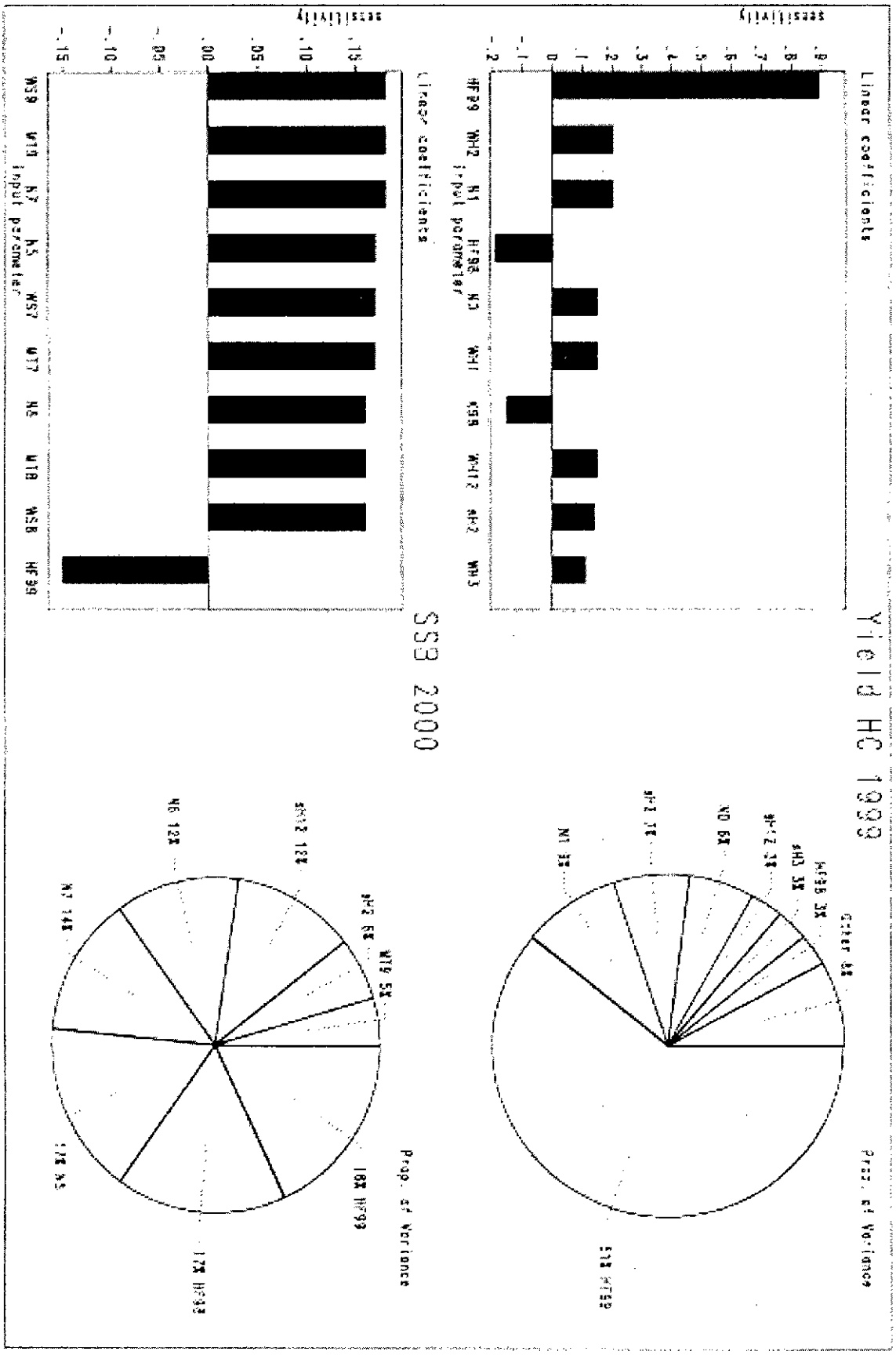


Figure 7.9.1 Sensitivity analysis of short term forecast for the Southern Horse Mackerel

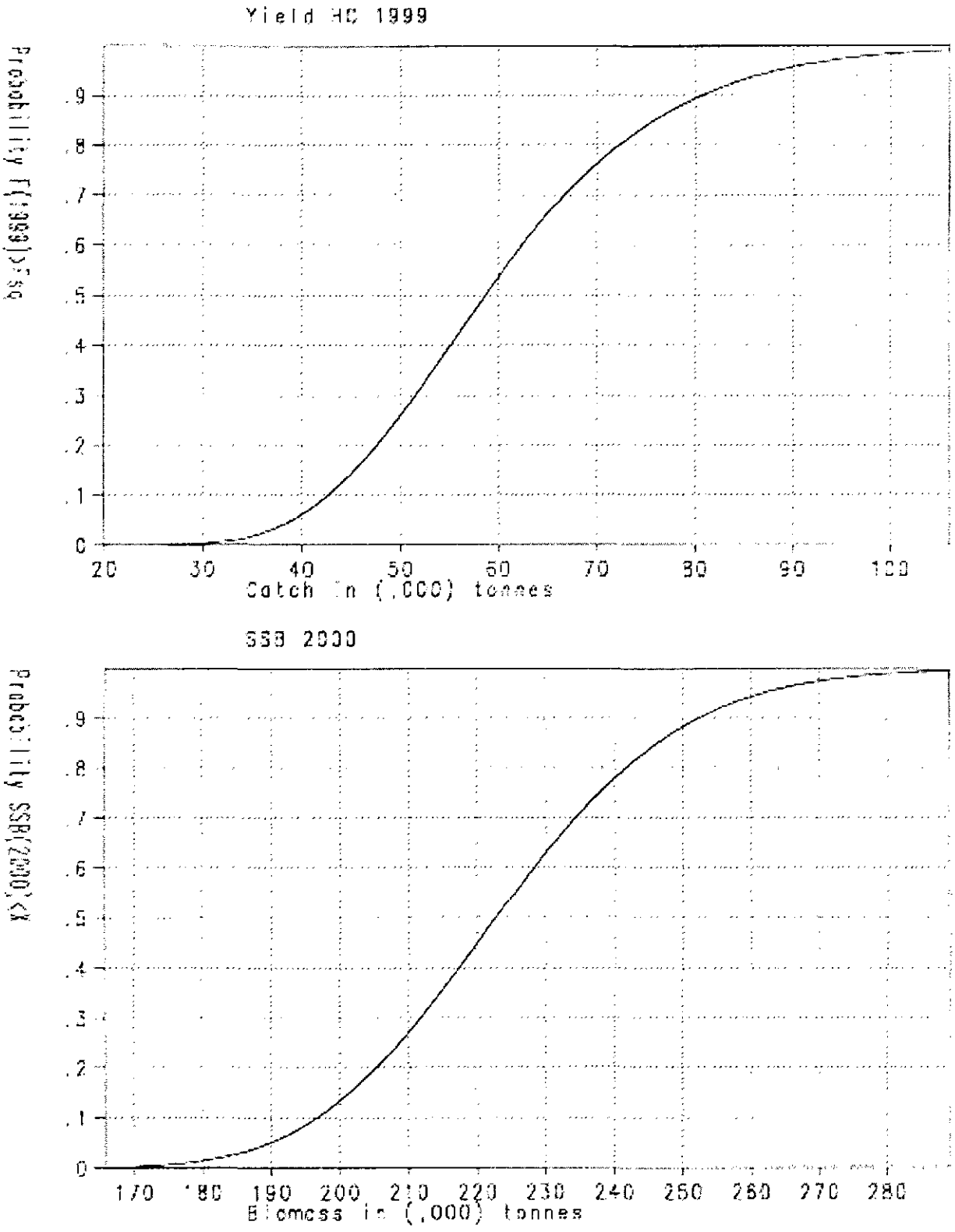


Figure 7.9.2 Probability profiles for short term forecast of the Southern Horse Mackerel

Figure 7.10.1 **Southern Horse Mackerel. Medium term projections. Solid lines show 5, 10, 20, 50 and 95 percentiles, number of simulations 500, Relative Cons. effort = 1.0**

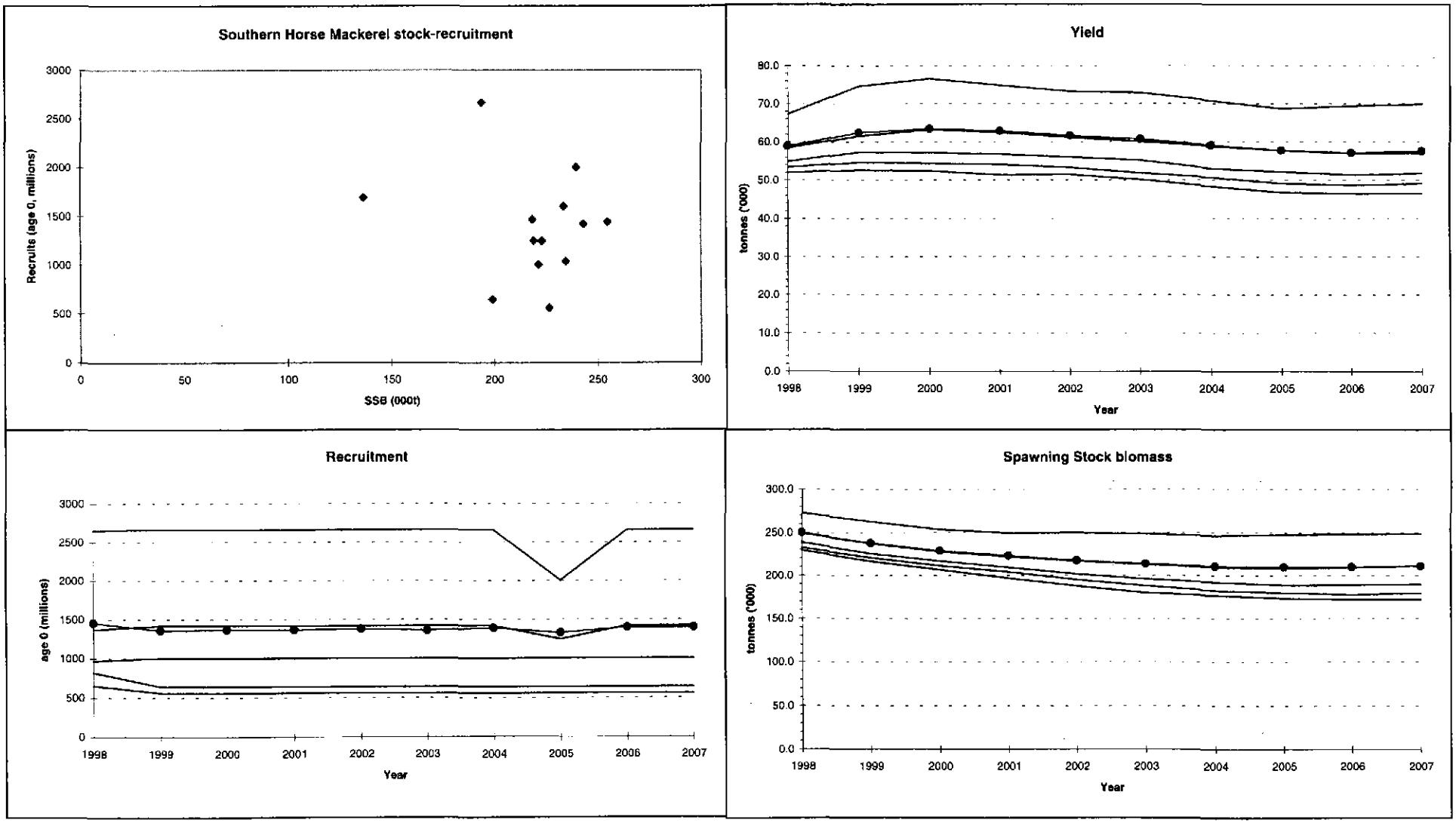


Figure 7.10.2 Southern Horse Mackerel - Medium term predictions with 5th,10th, 20th and 50th percentiles of SSB in 2000 for different F-factors applied to status quo F. 500 simulations.

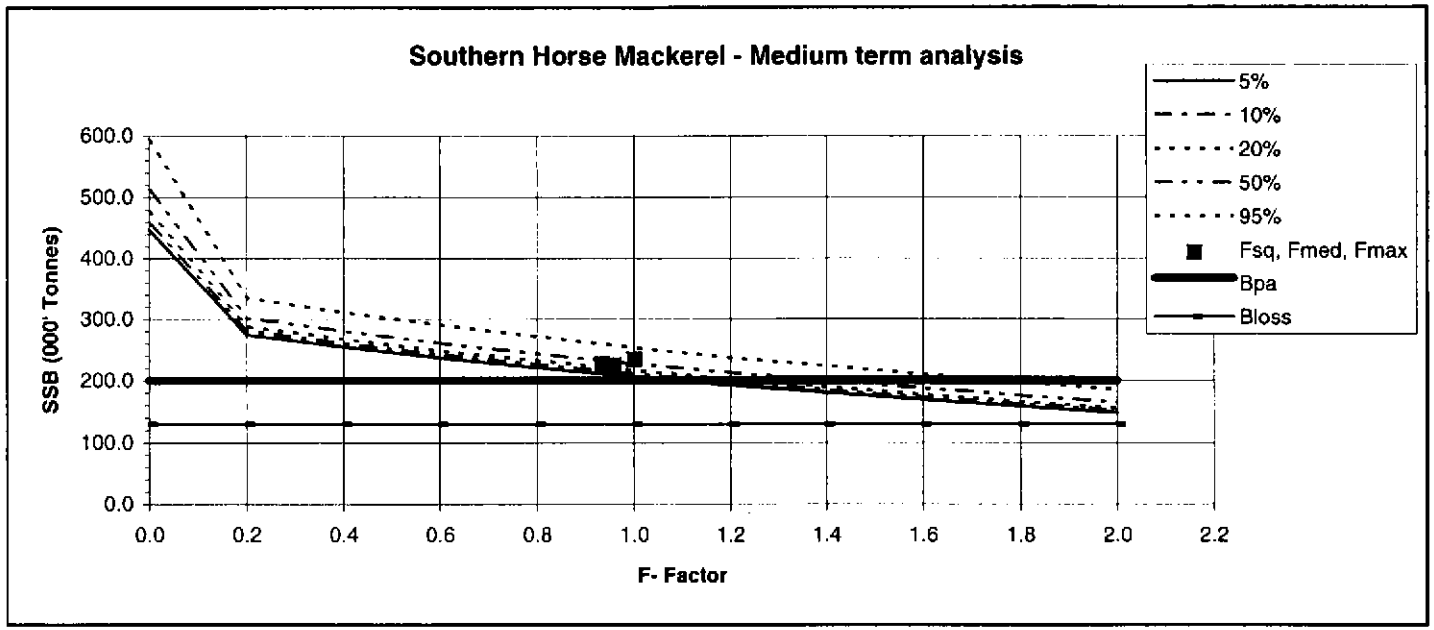


Figure 7.10.3 Southern Horse Mackerel - Medium term predictions with 5th,10th, 20th and 50th percentiles of SSB in 2007 for different F-factors applied to status quo F. 500 simulations.

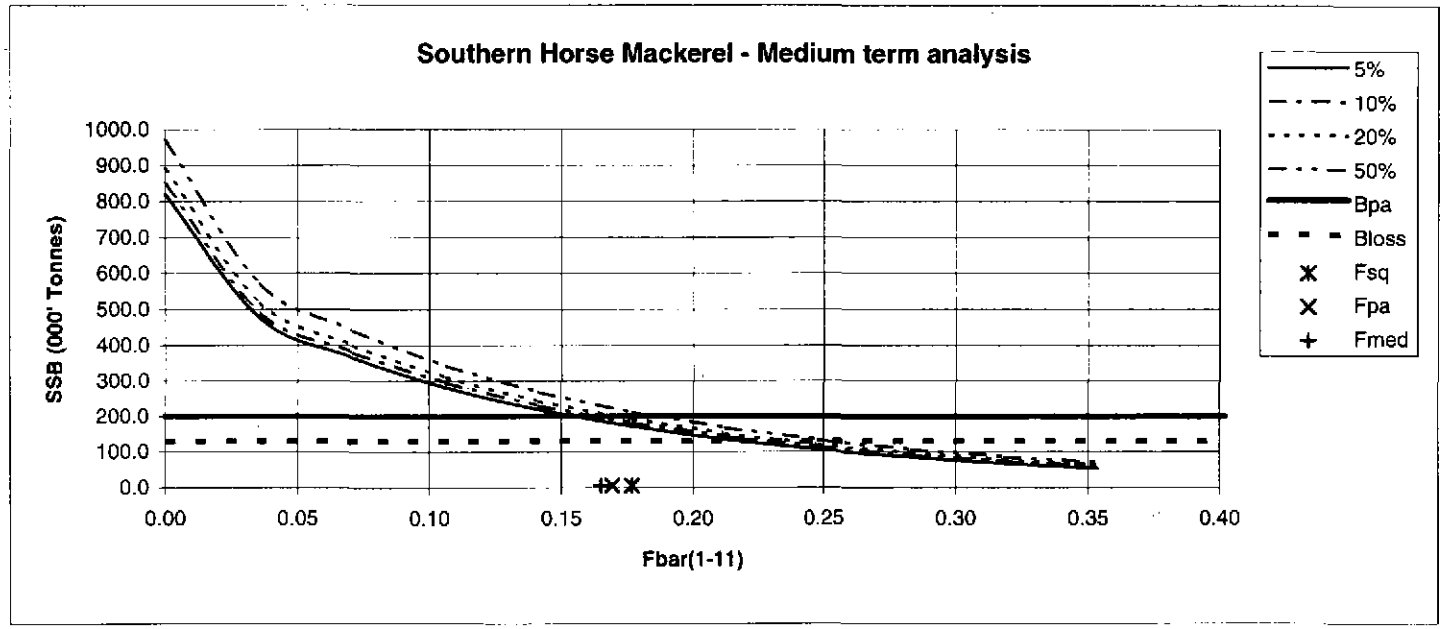
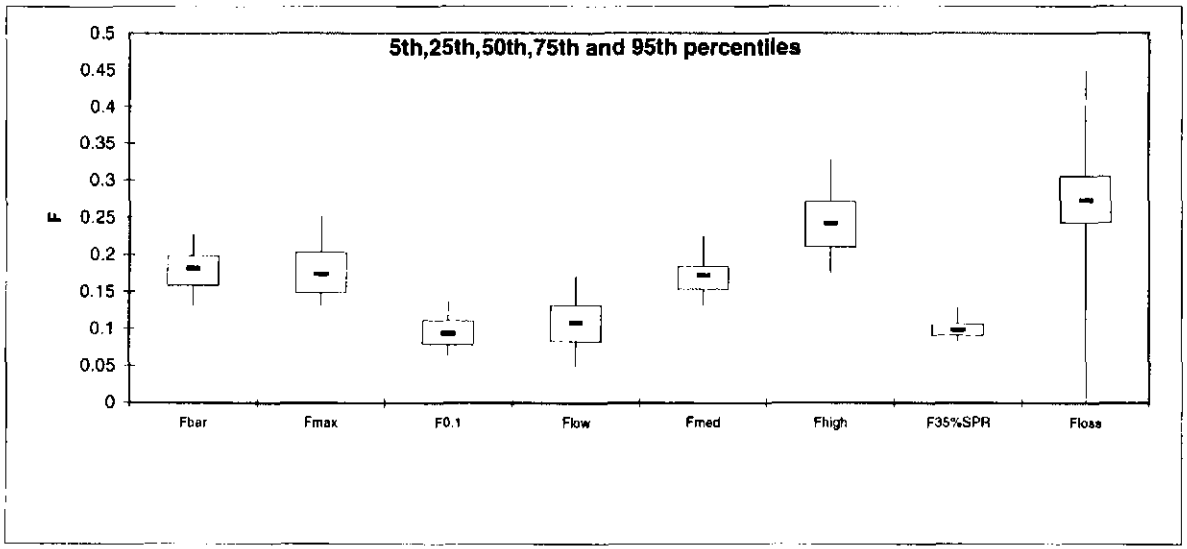


Figure 7.12.1 Estimates of some biological reference points for southern horse mackerel.



Reference point	Deterministic	Median	95th percentile	80th percentile
MedianRecruits	1419000	1419000	1465000	1440000
MBAL				
Bloss	136300			
SSB90%R90%Surv	171497	207830	240270	234222
SPR%ofVirgin	18.56	18.11	30.12	22.78
VirginSPR	0.84	0.84	1.29	1.05
SPRloss	0.08	0.08	137525.40	0.08

	Deterministic	Median	5th percentile	20th percentile
FBar	0.18	0.18	0.13	0.16
Fmax	0.17	0.17	0.13	0.15
F0.1	0.09	0.09	0.07	0.08
Flow	0.10	0.11	0.05	0.08
Fmed	0.16	0.17	0.13	0.15
Fhigh	0.26	0.24	0.18	0.21
F35%SPR	0.10	0.10	0.08	0.09
Floss	0.27	0.27	0.00	0.23

o:\acfm\wgreps\wgmhsa\reports\1999\f-7121.xls

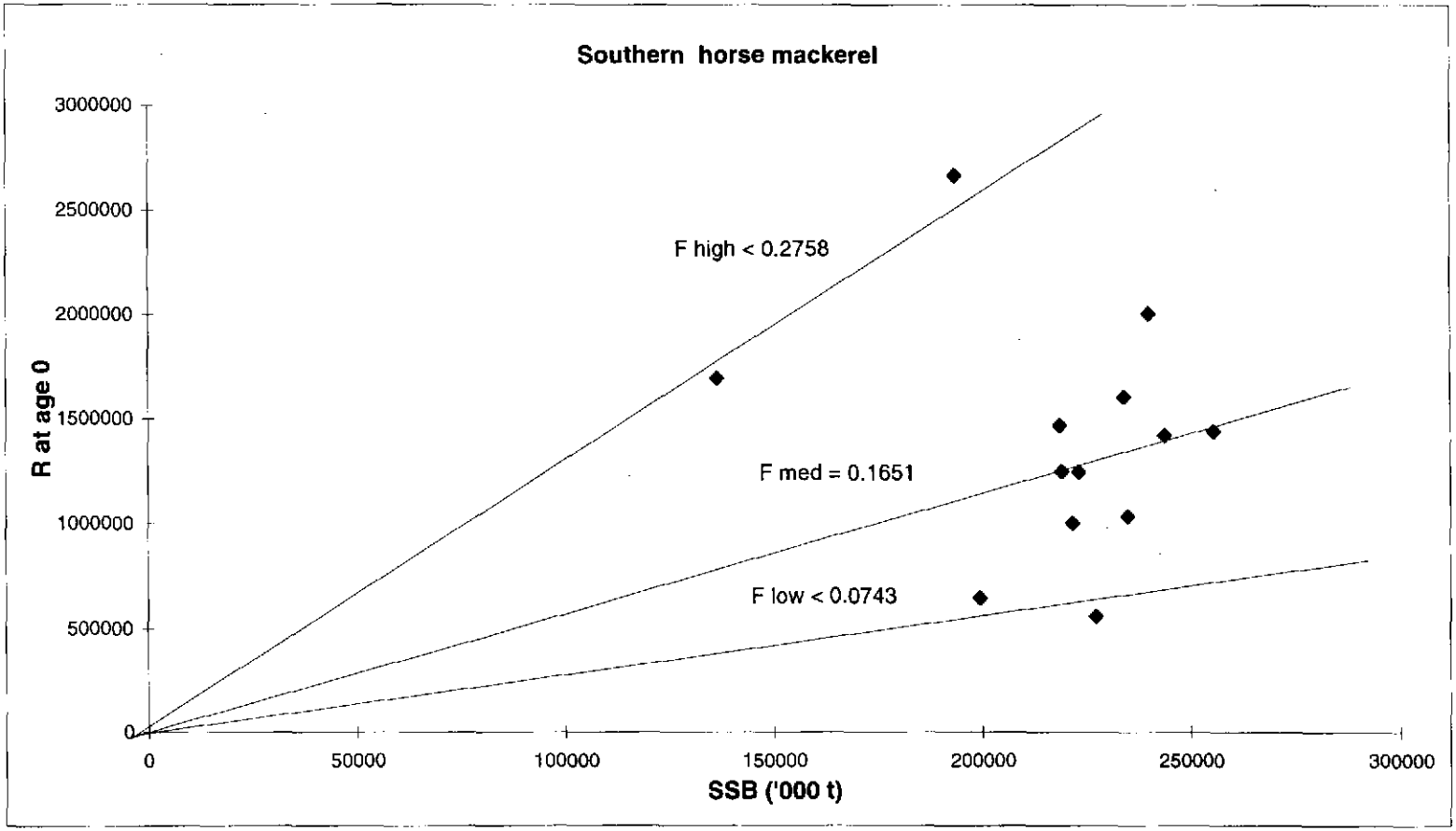


Figure 7.12.2 Recruits (age 0) versus Spawning Stock Biomass.

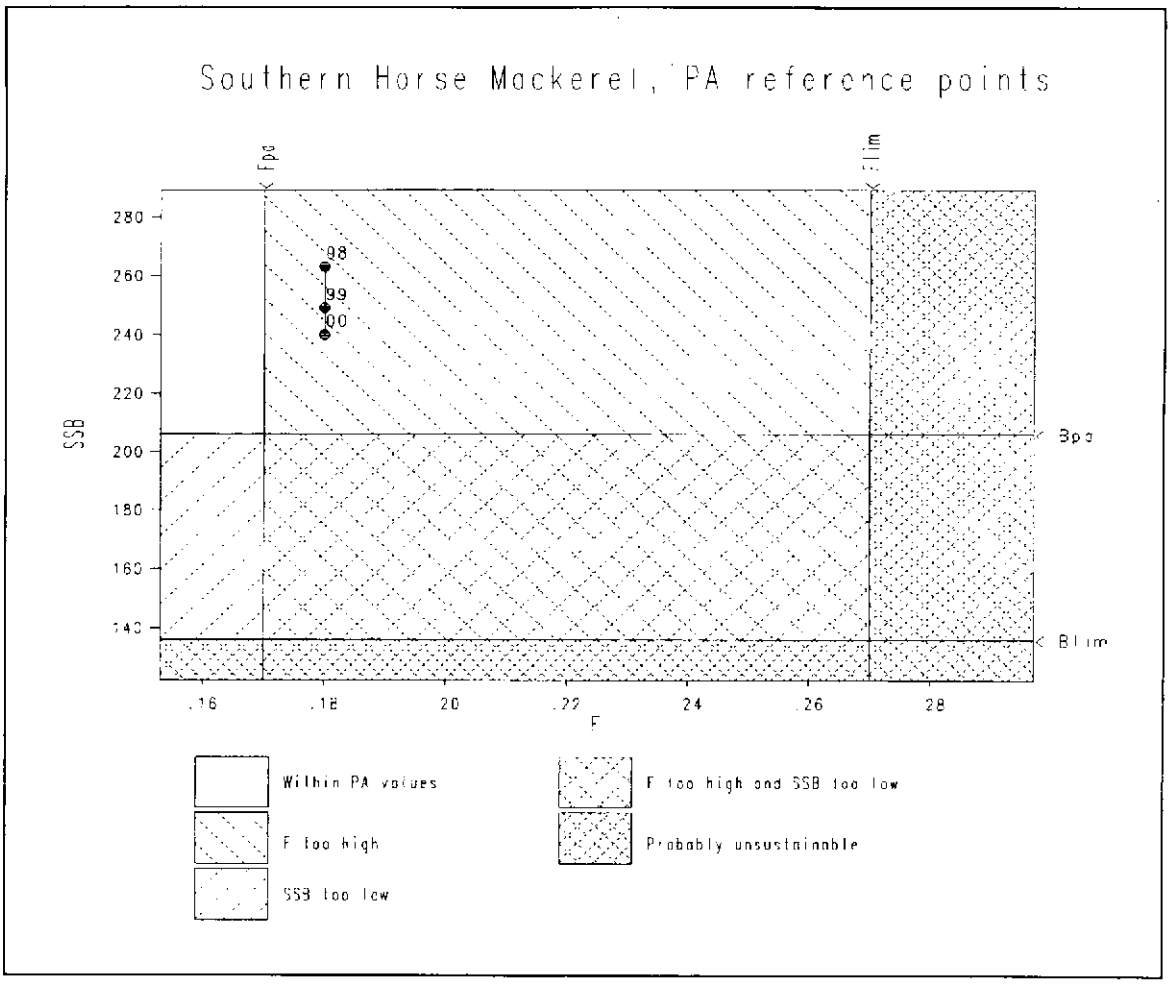


Figure 7.14.1 Predicted SSB in 1998, 1999 and 2000, and PA reference points for the Southern Horse Mackerel.